User Manual

Allen-Bradley

Kinetix 350 Single-axis EtherNet/IP Servo Drives

Catalog Numbers 2097-V31PR0-LM, 2097-V31PR2-LM,
2097-V32PR0-LM, 2097-V32PR2-LM, 2097-V32PR4-LM,
2097-V33PR1-LM, 2097-V33PR3-LM, 2097-V33PR5-LM, 2097-V33PR6-LM,
2097-V34PR3-LM, 2097-V34PR5-LM, 2097-V34PR6-LM

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Chapter 4

Connect the Kinetix 350 Drive System

Chapter 5

Configure and Start Up the Kinetix 350 Drive System

Chapter 6

Kinetix 350 Drive Safe Torque-off Feature

Chapter 7

Troubleshoot the Kinetix 350 Drive

Specifications and Dimensions

Appendix A

Interconnect Diagrams

Appendix B

Upgrade the Kinetix 350 Drive Firmware

Appendix C

About This Publication

This manual provides detailed installation instructions for mounting, wiring, and troubleshooting your Kinetix® 350 drive; and system integration for your drive/motor combination with a Logix controller.

Who Should Use This Manual

This manual is intended for engineers and technicians directly involved in the installation and wiring of the Kinetix 350 drive and programmers directly involved in operation, field maintenance, and integration of the Kinetix 350 drive.

If you do not have a basic understanding of the Kinetix 350 drive, contact your local Rockwell Automation sales representative for information on available training courses.

Conventions Used in This Manual

The conventions starting below are used throughout this manual:

- Bulleted lists such as this one provide information, not procedural steps.
- Numbered lists provide sequential steps or hierarchical information.

Additional Resources

These documents contain additional information concerning related products from Rockwell Automation.

Resource	Description
Kinetix 350 Single-axis EtherNet/IP Servo Drive Installation Instructions, publication 2097-IN008	Information on installing your Kinetix 350 drive system.
Kinetix 300 Shunt Resistor Installation Instructions, publication 2097-IN002	Information on installing and wiring the Kinetix 300 shunt resistors.
Kinetix 300 AC Line Filter Installation Instructions, publication 2097-IN003	Information on installing and wiring the Kinetix 300 AC line filter.
Kinetix 300 I/O Terminal Expansion Block Installation Instructions, publication 2097-IN005	Information on installing and wiring the Kinetix 300 I/O terminal expansion block.
CompactLogix L3ER Controllers User Manual, publication 1769-UM021	Information on installing, configuring, programming, and operating a CompactLogix" system.
Stratix 2000 Ethernet Unmanaged Switches Installation Instructions, publication 1783-IN001	Information on installing and operating a Stratix 2000" Ethernet Switches.
Ethernet/IP Benefits of Industrial Connectivity in Industrial Apps White Paper, publication 1585-WP001A	Provides general guidelines and theory for Ethernet/IP industrial systems.
Industrial Ethernet Media, publication 1585-BR001	This brochure provides connectivity solutions for Ethernet networks and integrated architecture.
Guidance for Selecting Cables for EtherNet/IP Networks White Paper, publication ENET-WP007	This guide is arranged to help you select cabling based on the application, environmental conditions, and mechanical requirements
Integrated Motion on SERCOS and EtherNet/IP Systems - Analysis and Comparison White Paper, publication MOTION-WP007	This white paper compares and contrasts SERCOS and EtherNet/IP with a ControlLogix Controller.
Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1	Provides general guidelines for installing a Rockwell Automation industrial system.
System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001	Information, examples, and techniques designed to minimize system failures caused by electrical noise.
EMC Noise Management DVD, publication GMC-SP004	
Kinetix Motion Control Selection Guide, publication GMC-SG001	Specifications, motor/servo-drive system combinations, and accessories for Kinetix motion control products.
Motion Analyzer software, download at http://www.ab.com/e-tools	Drive and motor sizing with application analysis software.
ControlLogix Controllers User Manual, publication 1756-UM001	Information on installing, configuring, programming, and operating a ControlLogix system.
CIP Motion Configuration and Startup User Manual, publication MOTION-UM003	Information on configuring and troubleshooting your ControlLogix and CompactLogix EtherNet/IP network modules.
ControlFLASH Firmware Upgrade Kit User Manual, publication 1756-QS105	For ControlFLASH information not specific to any drive family.
Rockwell Automation Configuration and Selection Tools, website http://www.ab.com/e-tools	Online product selection and system configuration tools, including AutoCAD (DXF) drawings.
Rockwell Automation Product Certification, website http://www.rockwellautomation.com/products/certification	For declarations of conformity (DoC) currently available from Rockwell Automation.
National Electrical Code, published by the National Fire Protection Association of Boston, MA	An article on wire sizes and types for grounding electrical equipment.
Rockwell Automation Industrial Automation Glossary, publication AG-7.1	A glossary of industrial automation terms and abbreviations.

You can view or download publications at http://www.rockwellatuomation.com/literature. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Start

Introduction

Use this chapter to become familiar with the Kinetix 350 drive components. This chapter also reviews design and installation requirements for Kinetix 350 drive systems.

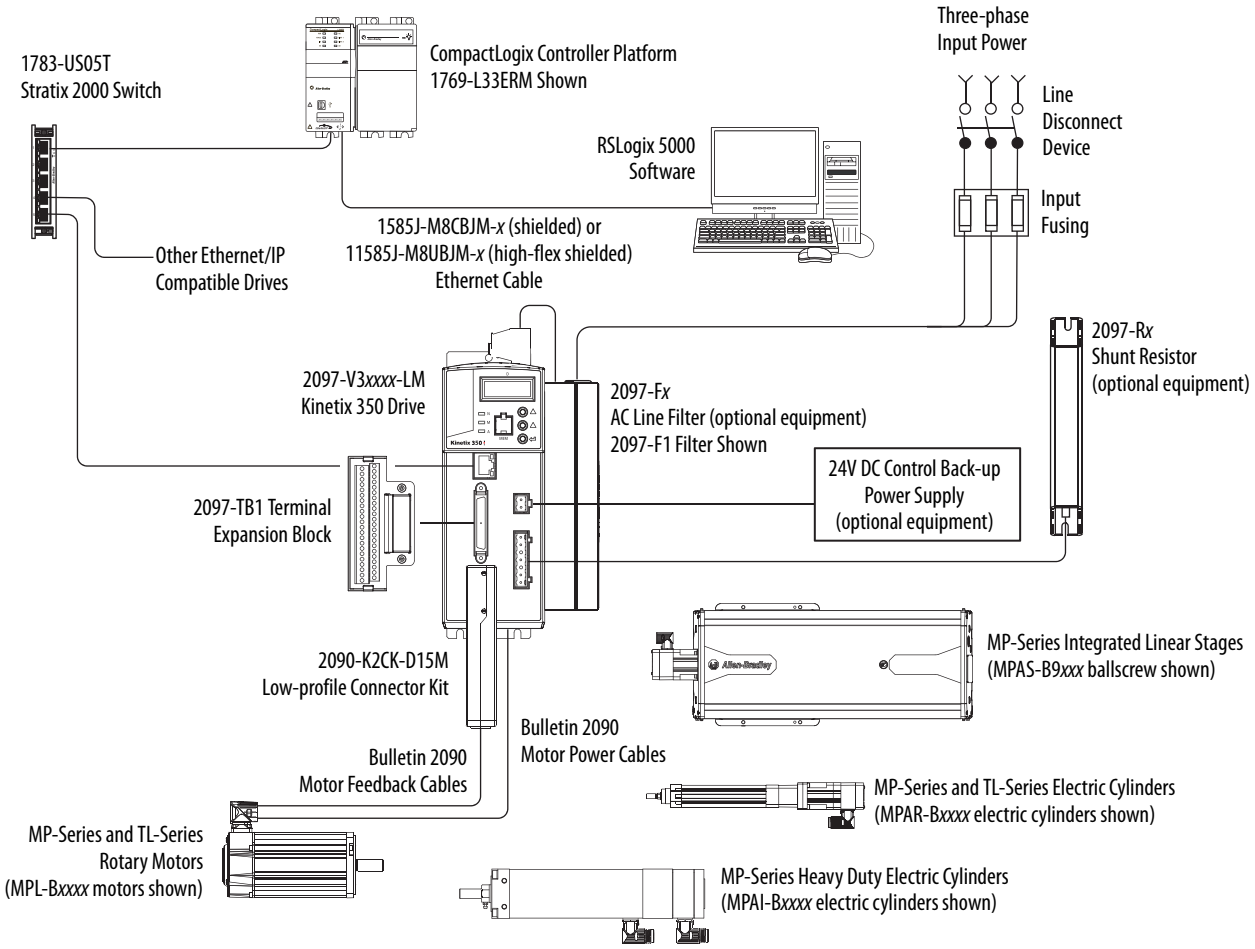
About the Kinetix 350 Drive System

The Kinetix 350 single-axis EtherNet/IP servo drive is designed to provide a solution for applications with output power requirements between 0.4...3.0 kW (2...12 A rms).

Table 1 - Kinetix 350 Drive System Overview

Kinetix 350 System Component	Cat. No.	Description
Kinetix 350 Single-axis EtherNet/IP Servo Drive	2097-V3*x*PR*x*-LM	Kinetix 350 Single-axis EtherNet/IP drives with safe torque-off feature are available with 120/240V or 480V AC input power.
AC Line Filters	2090 2097-F*x*	Bulletin 2090 and Bulletin 2097-F*x* AC line filters are required to meet CE with Kinetix 350 drives without an integrated line filter. Bulletin 2097 filters are available in foot mount and side mount.
Shunt Module	2097-R*x*	Bulletin 2097 shunt resistors connect to the drive and provide shunting capability in regenerative applications.
Terminal block for I/O connector	2097-TB1	50-pin terminal block. Use with IOD connector for control interface connections.
Stratix 2000 Ethernet Switch	1783-US05T	An Ethernet switch divides an Ethernet network into segments and directs network traffic efficiently.
Logix Controller Platform	1769-L18ERM-BB1B 1769-L27ERM-QBFC1B 1769-L33ERM 1769-L36ERM 1769-L30ERM 1756-L6x 1756-L7x	CompactLogix controller with integrated dual-port Ethernet/IP interface serves as communication link with the Kinetix 350 drive system. The communication link uses EtherNet/IP protocol over a copper cable.
RSLogix 5000 Software	9324-RLD300ENE	RSLogix 5000 software (version 20.*xx* or later) provides support for programming, commissioning, and maintaining the Logix family of controllers.
Rotary Servo Motors	MP-Series, TL-Series	Compatible rotary motors include the MP-Series (Bulletin MPL, MPM, MPF, and MPS) and TL-Series (Bulletin TLY) motors.
Linear Stages	MP-Series (Ballscrew)	Compatible stages include MP-Series (Bulletin MPAS) Integrated Linear Stages.
Electric Cylinders	MP-Series, TL-Series	Compatible electric cylinders include MP-Series and TL- Series (Bulletin MPAR, TLAR, and MPAI) Electric Cylinders.
Cables	Motor/brake and feedback cables	Motor power/brake and feedback cables include SpeedTec and threaded DIN connectors at the motor. Power/brake cables have flying leads on the drive end and straight connectors that connect to servo motors. Feedback cables have flying leads that wire to low-profile connector kits on the drive end and straight connectors on the motor end.
	Communication cables	1585J-M8CBJM-*x* (shielded) or 1585J-M8UBJM-x (high-flex shielded) Ethernet cable.

Figure 1 - Typical Kinetix 350 Drive Installation



Catalog Number Explanation

Kinetix 350 drive catalog numbers and descriptions are listed in these tables.)

Table 2 - Kinetix 350 Drives (single-phase)

Cat. No.	Description
2097-V31PR0-LM	Kinetix 350,120/240V, 1 Ø, 2.0 A
2097-V31PR2-LM	Kinetix 350, 120/240V, 1 Ø, 4.0 A
2097-V32PR0-LM	Kinetix 350, 240V, 1 Ø, 2.0 A, with integrated filter
2097-V32PR2-LM	Kinetix 350, 240V, 1 Ø, 4.0 A, with integrated filter
2097-V32PR4-LM	Kinetix 350, 240V, 1 Ø, 8.0 A, with integrated filter

Table 3 - Kinetix 350 Drives (single/three-phase

Cat. No.	Description
2097-V33PR1-LM	Kinetix 350, 120V 1 Ø, 240V 3 Ø, 2.0 A
2097-V33PR3-LM	Kinetix 350, 120V 1 Ø, 240V 3 Ø, 4.0 A
2097-V33PR5-LM	Kinetix 350, 120V 1 Ø, 240V 3 Ø, 8.0 A
2097-V33PR6-LM	Kinetix 350, 120V 1 Ø, 240V 3 Ø, 12.0 A

Table 4 - Kinetix 350 Drives (three-phase)

Cat. No.	Description
2097-V34PR3-LM	Kinetix 350, 480V, 3 Ø, 2.0 A
2097-V34PR5-LM	Kinetix 350, 480V, 3 Ø, 4.0 A
2097-V34PR6-LM	Kinetix 350, 480V, 3 Ø, 6.0 A

Kinetix 350 Drive Accessories

Cat. No.	Drive Components
2097-F*x*	AC line filters
2097-TB1	Terminal block for I/O connector
2097-R*x*	Shunt resistors

Agency Compliance

If this product is installed within the European Union and has the CE mark, the following regulations apply.

ATTENTION: Meeting CE requires a grounded system. The method of grounding the AC line filter and drive must match. Failure to do this renders the filter ineffective and may cause damage to the filter.
For grounding examples, refer to Grounding Your Kinetix 350 Drive System on page 54.

For more information on electrical noise reduction, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

CE Requirements

To meet CE requirements, these requirements apply:

- Install an AC line filter (Bulletin 2090 or 2097) as close to the drive as possible.
- Use 2090 series motor power cables or use connector kits and terminate the cable shields to the subpanel with clamp provided.
- Use 2090 series motor feedback cables or use connector kits and properly terminate the feedback cable shield. Drive-to-motor power and feedback cables must not exceed 20 m (65.6 ft).
- Install the Kinetix 350 system inside an enclosure. Run input power wiring in conduit (grounded to the enclosure) outside of the enclosure. Separate signal and power cables.
- Segregate input power wiring and motor power cables from control wiring and motor feedback cables. Use shielded cable for power wiring and provide a grounded 360° clamp termination.

Refer to Appendix B on page 141 for interconnect diagrams, including input power wiring and drive/motor interconnect diagrams.

Notes:

Install the Kinetix 350 Drive System

Introduction

This chapter describes system installation guidelines used in preparation for mounting your Kinetix 350 drive components.

ATTENTION: Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

System Design Guidelines

Use the information in this section when designing your enclosure and planning to mount your system components on the panel.

For on-line product selection and system configuration tools, including AutoCAD (DXF) drawings of the product, refer to http://www.ab.com/e-tools.

System Mounting Requirements

- To comply with UL and CE requirements, the Kinetix 350 system must be enclosed in a grounded conductive enclosure offering protection as defined in standard EN 60529 (IEC 529) to IP4X such that they are not accessible to an operator or unskilled person. A NEMA 4X enclosure exceeds these requirements providing protection to IP66.
- The panel you install inside the enclosure for mounting your system components must be on a flat, rigid, vertical surface that won't be subjected to shock, vibration, moisture, oil mist, dust, or corrosive vapors.
- Size the drive enclosure so as not to exceed the maximum ambient temperature rating. Consider heat dissipation specifications for all drive components.
- Segregate input power wiring and motor power cables from control wiring and motor feedback cables. Use shielded cable for power wiring and provide a grounded 360° clamp termination.
- Use high-frequency (HF) bonding techniques to connect the enclosure, machine frame, and motor housing, and to provide a low-impedance return path for high-frequency (HF) energy and reduce electrical noise.
- Use 2090 series motor feedback cables or use connector kits and properly terminate the feedback cable shield. Drive-to-motor power and feedback cables must not exceed 20 m (65.6 ft).

IMPORTANT	System performance was tested at these cable length specifications. These limitations are also a CE requirement.

Refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, to better understand the concept of electrical noise reduction.

Transformer Selection

The Kinetix 350 drive does not require an isolation transformer for three-phase input power. However, a transformer may be required to match the voltage requirements of the controller to the available service.

To size a transformer for the main AC power inputs, refer to Circuit Breaker/ Fuse Specifications on page 131 and Transformer Specifications for Input Power on page 132.

IMPORTANT	If using an autotransformer, make sure that the phase to neutral/ground voltages do not exceed the input voltage ratings of the drive.

IMPORTANT	Use a form factor of 1.5 for single and three-phase power (where form factor is used to compensate for transformer, drive, and motor losses, and to account for utilization in the intermittent operating area of the torque speed curve). For example, sizing a transformer to the voltage requirements of catalog number 2097-V34PR6-LM = 3 kW continuous x 1.5 = 4.5 KVA transformer.

Circuit Breaker/Fuse Selection

The Kinetix 350 drives use internal solid-state motor short-circuit protection and, when protected by suitable branch circuit protection, are rated for use on a circuit capable of delivering up to 100,000 A. Fuses or circuit breakers that are adequate and can withstand interrupt ratings, as defined in NEC or applicable local codes, are permitted.

The Bulletin 140M and 140U products are another acceptable means of protection. As with fuses and circuit breakers, you must make sure that the selected components are properly coordinated and meet applicable codes including any requirements for branch circuit protection. When applying the 140M/140U product, evaluation of the short circuit available current is critical and must be kept below the short circuit current rating of the 140M/140U product.

In most cases, class CC, J, L, and R fuses selected to match the drive input current rating will meet the NEC requirements or applicable local codes, and provide the full drive capabilities. Use dual element, time delay (slow-acting) fuses to avoid nuisance trips during the inrush current of power initialization.

Refer to Kinetix 350 Drive Power Specifications on page 128 for input current and inrush current specifications for your Kinetix 350 drive.

Refer to Circuit Breaker/Fuse Specifications on page 131 for recommended circuit breakers and fuses.

Enclosure Selection

This example is provided to assist you in sizing an enclosure for your Bulletin 2097 drive system. You need heat dissipation data from all components planned for your enclosure to calculate the enclosure size.

With no active method of heat dissipation (such as fans or air conditioning) either of the following approximate equations can be used.

Metric	Standard English
$A = \frac{0.38Q}{1.8T - 1.1}$	$A = \frac{4.08Q}{T - 1.1}$
Where T is temperature difference between inside air and outside ambient (°C), Q is heat generated in enclosure (Watts), and A is enclosure surface area (m^2). The exterior surface of all six sides of an enclosure is calculated as	Where T is temperature difference between inside air and outside ambient (°F), Q is heat generated in enclosure (Watts), and A is enclosure surface area (ft^2). The exterior surface of all six sides of an enclosure is calculated as
$A = 2dw + 2dh + 2wh$	$A = (2dw + 2dh + 2wh) /144$
Where d (depth), w (width), and h (height) are in meters.	Where d (depth), w (width), and h (height) are in inches.

If the maximum ambient rating of the Kinetix 350 drive system is 40 °C (104 °F) and if the maximum environmental temperature is 20 °C (68 °F), then T=20. In this example, the total heat dissipation is 416 W (sum of all components in enclosure). So, in the equation below, T=20 and Q=416.

$$A = \frac{0.38\ (416)}{1.8\ (20) - 1.1} = 4.53\ m^2$$

In this example, the enclosure must have an exterior surface of at least 4.53 m^2. If any portion of the enclosure is not able to transfer heat, do not include heat in the calculation.

Because the minimum cabinet depth to house the Kinetix 350 system (selected for this example) is 332 mm (13 in.), the cabinet needs to be approximately 2000 x 700 x 332 mm (78.7 x 27.6 x 13.0 in.) HxWxD.

$$2 \times (0.332 \times 0.70) + 2 \times (0.332 \times 2.0) + 2 \times (0.70 \times 2.0) = 4.59\ m^2$$

Because this cabinet size is considerably larger than what is necessary to house the system components, it may be more efficient to provide a means of cooling in a smaller cabinet. Contact your cabinet manufacturer for options available to cool your cabinet.

Minimum Clearance Requirements

This section provides information to assist you in sizing your cabinet and positioning your Kinetix 350 system components.

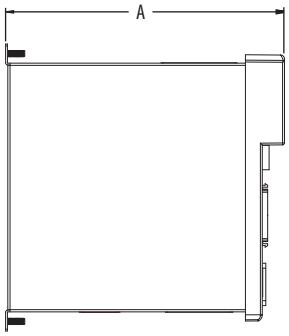
IMPORTANT Mount the module in an upright position as shown. Do not mount the drive module on its side.

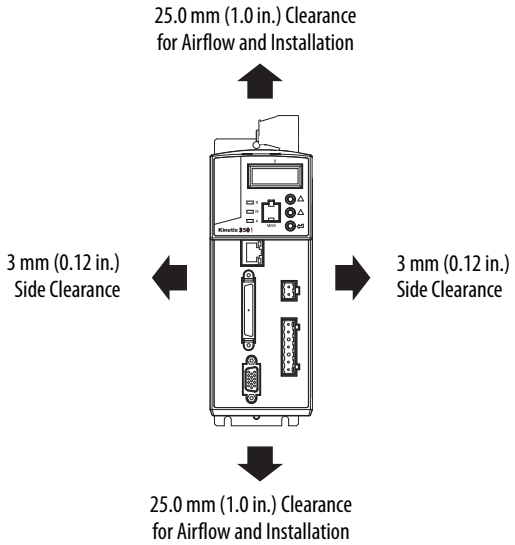
Figure 2 illustrates minimum clearance requirements for proper airflow and installation:

- Additional clearance is required depending on the accessory items installed.
- An additional 9.7 mm (0.38 in.) clearance is required left of the drive if the I/O expansion terminal block is used.
- An additional 26 mm (1.0 in.) clearance is required right of the drive when the heatsink is present.
- An additional 36 mm (1.42 in.) is required right of the drive when the side-mount line filter is present. An additional 50 mm (2.0 in.) is required behind the drive when the rear-mount line filter is present.
- An additional 5.0 mm (0.19 in.) clearance is required in front of the drive when the 2090-K2CK-D15M feedback connector kit is used.
- Additional clearance is required for the cables and wires connected to the top, front, and bottom of the drive.
- An additional 150 mm (6.0 in.) is required when the drive is mounted adjacent to noise sensitive equipment or clean wireways.

Refer to page 137 for Kinetix 350 drive dimensions.

Figure 2 - Minimum Clearance Requirements





Drive Cat. No.	A
2097-V31PR0-LM	185 (7.29)
2097-V31PR2-LM	185 (7.29)
2097-V32PR0-LM	230 (9.04)
2097-V32PR2-LM	230 (9.04)
2097-V32PR4-LM	230 (9.04)
2097-V33PR1-LM	185 (7.29)
2097-V33PR3-LM	185 (7.29)
2097-V33PR5-LM	185 (7.29)
2097-V33PR6-LM	230 (9.04)
2097-V34PR3-LM	185 (7.29)
2097-V34PR5-LM	185 (7.29)
2097-V34PR6-LM	230 (9.04)

Refer to page 133 for power dissipation specifications.

Electrical Noise Reduction

This section outlines best practices that minimize the possibility of noise-related failures as they apply specifically to Kinetix 350 system installations. For more information on the concept of high-frequency (HF) bonding, the ground plane principle, and electrical noise reduction, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Bonding Drives

Bonding is the practice of connecting metal chassis, assemblies, frames, shields, and enclosures to reduce the effects of electromagnetic interference (EMI).

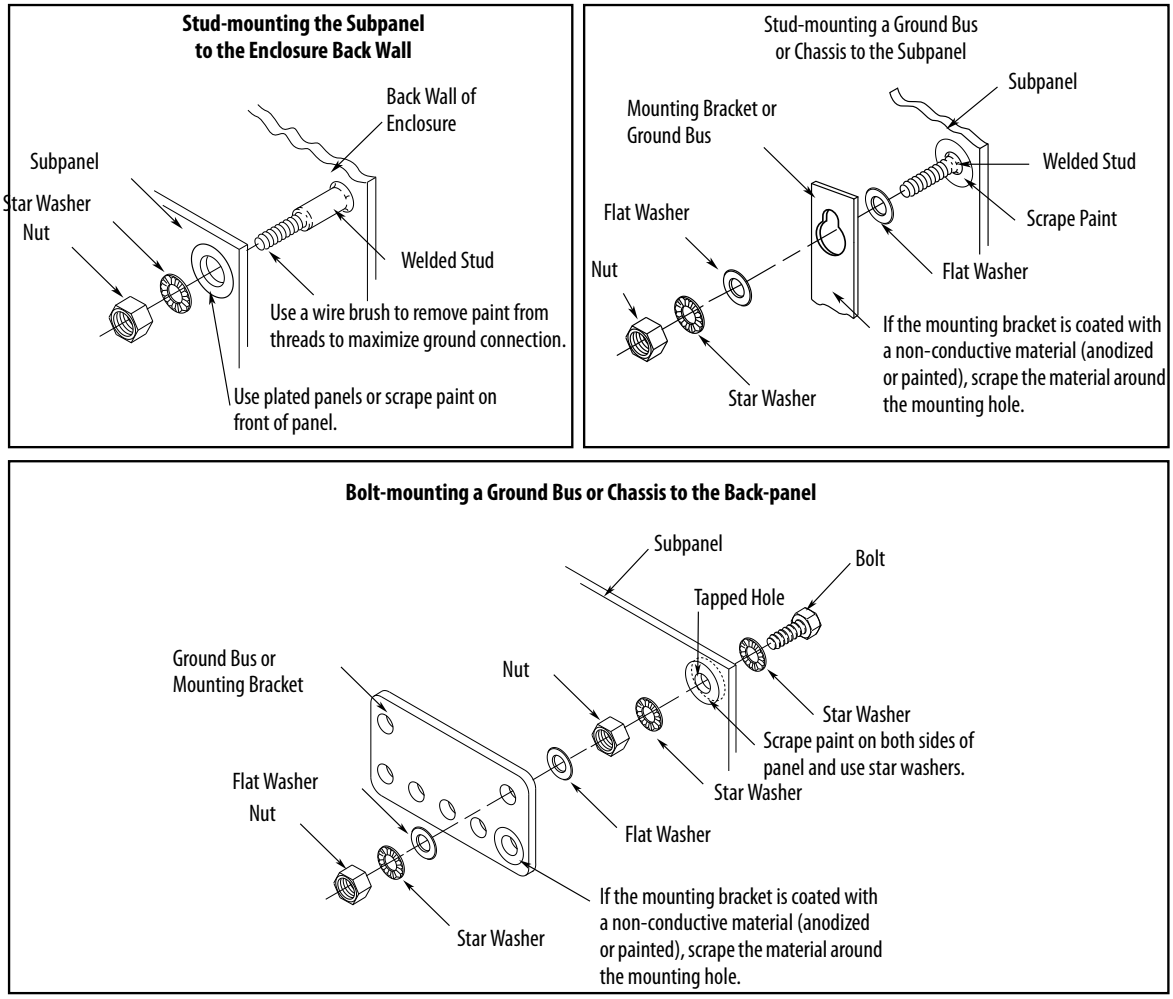
Unless specified, most paints are not conductive and act as insulators. To achieve a good bond between drive and the subpanel, surfaces need to be paint-free or plated. Bonding metal surfaces creates a low-impedance return path for high-frequency energy.

IMPORTANT To improve the bond between the drive and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

Improper bonding of metal surfaces blocks the direct return path and allows high-frequency energy to travel elsewhere in the cabinet. Excessive high-frequency energy can effect the operation of other microprocessor controlled equipment.

These illustrations show recommended bonding practices for painted panels, enclosures, and mounting brackets.

Figure 3 - Recommended Bonding Practices for Painted Panels

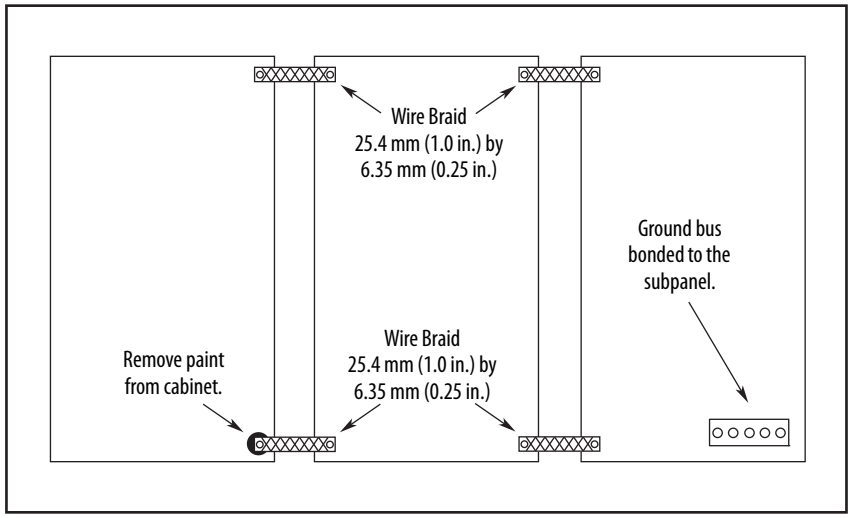


Bonding Multiple Subpanels

Bonding multiple subpanels creates a common low impedance exit path for the high frequency energy inside the cabinet. Subpanels that are not bonded together may not share a common low impedance path. This difference in impedance may affect networks and other devices that span multiple panels:

- Bond the top and bottom of each subpanel to the cabinet by using 25.4 mm (1.0 in.) by 6.35 mm (0.25 in.) wire braid. As a rule, the wider and shorter the braid is, the better the bond.
- Scrape the paint from around each fastener to maximize metal-to-metal contact.

Figure 4 - Multiple Subpanels and Cabinet Recommendations

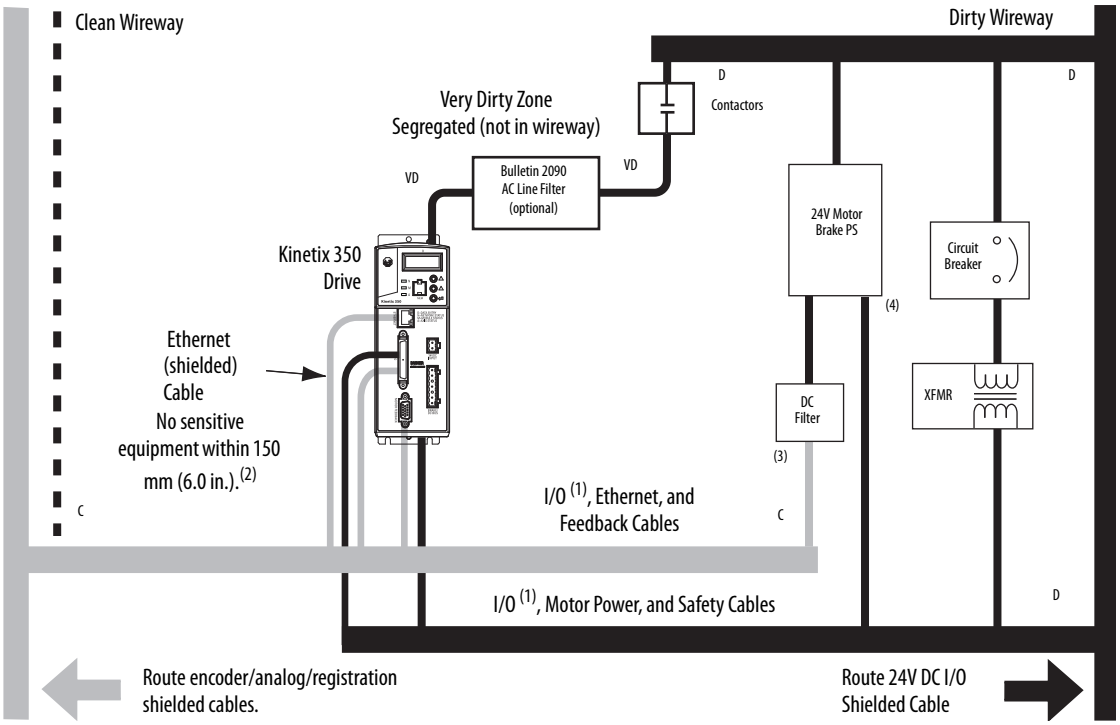


Establishing Noise Zones

Observe these guidelines when individual input power components are used in the Kinetix 350 system:

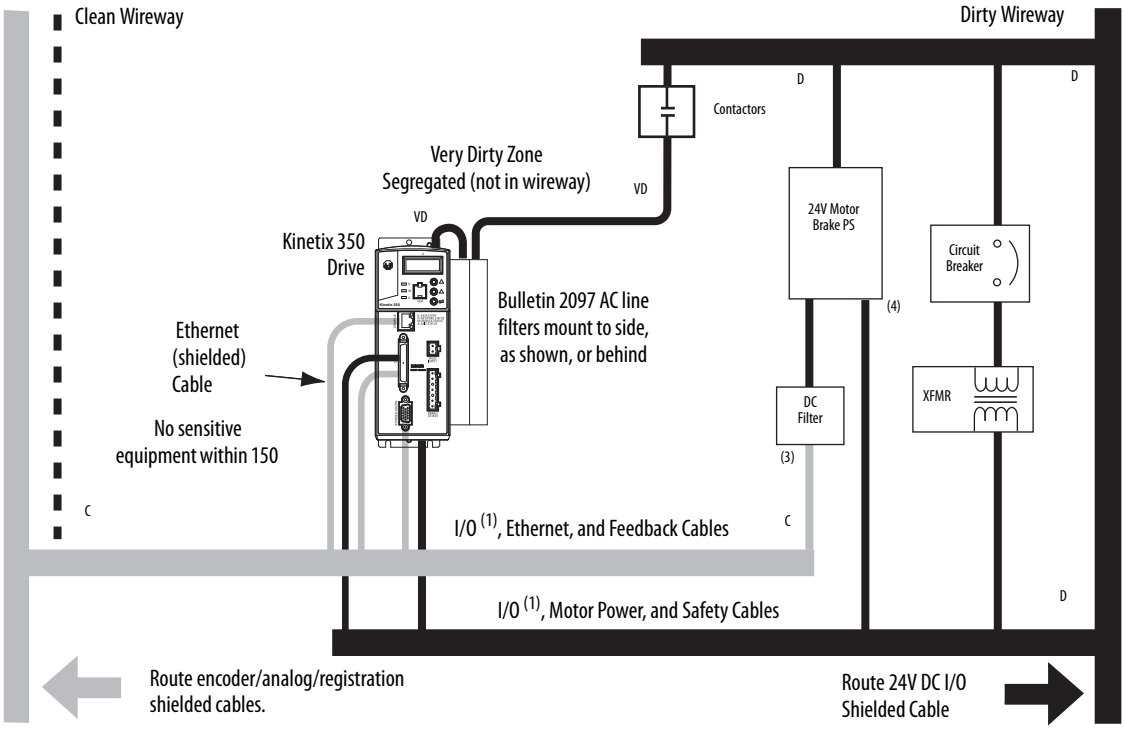
- The clean zone (C) exits left of the Kinetix 350 system and includes the I/O wiring, feedback cable, Ethernet cable, and DC filter (gray wireway).
- The dirty zone (D) exits right of the Kinetix 350 system (black wireway) and includes the circuit breakers, transformer, 24V DC power supply, contactors, AC line filter, motor power, and safety cables.
- The very dirty zone (VD) is limited to where the AC line (EMC) filter VAC output jumpers over to the drive. Shielded cable is required only if the very dirty cables enter a wireway.

Figure 5 - Noise Zones (Bulletin 2090 AC line filters)



(1) If drive system I/O cable contains (dirty) relay wires, route cable in dirty wireway.
(2) For tight spaces use a grounded steel shield. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.
(3) This is a clean 24V DC available for any device that may require it. The 24V enters the clean wireway and exits to the left.
(4) This is a dirty 24V DC available for motor brakes and contactors. The 24V enters the dirty wireway and exits to the right.

Figure 6 - Noise Zones (Bulletin 2097 AC line filters)



(1) If drive system I/O cable contains (dirty) relay wires, route cable in dirty wireway.
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(3) This is a clean 24V DC available for any device that may require it. The 24V enters the clean wireway and exits to the left.
(4) This is a dirty 24V DC available for motor brakes and contactors. The 24V enters the dirty wireway and exits to the right.

Cable Categories for Kinetix 350 Drive Components

These table indicate the zoning requirements of cables connecting to the Kinetix 350 drive components.

Table 5 - Kinetix 350 Drive Components

Wire/Cable	Connector	Zone			Method	
		Very Dirty	Dirty	Clean	Ferrite Sleeve	Shielded Cable
L1, L2, L3 (unshielded cable)	IPD	X				
U, V, W (motor power)	MP		X			X
B+-, B-, BR (shunt resistor)	BC		X			
24V DC	BP			X		
Control COM, 24V DC control, safety enable, and feedback signals for safe-off feature	STO		X			
Motor feedback	MF			X		X
Registration	IOD			X		X
Others			X			
Ethernet	Port 1			X		X

Noise Reduction Guidelines for Drive Accessories

Refer to this section when mounting an AC line filter or shunt resistor module for guidelines designed to reduce system failures caused by excessive electrical noise.

AC Line Filters

If you are using a Bulletin 2090 line filter, mount the filter on the same panel as the Kinetix 350 drive, and as close to the drive as possible.

Observe these guidelines when mounting your AC line filter:

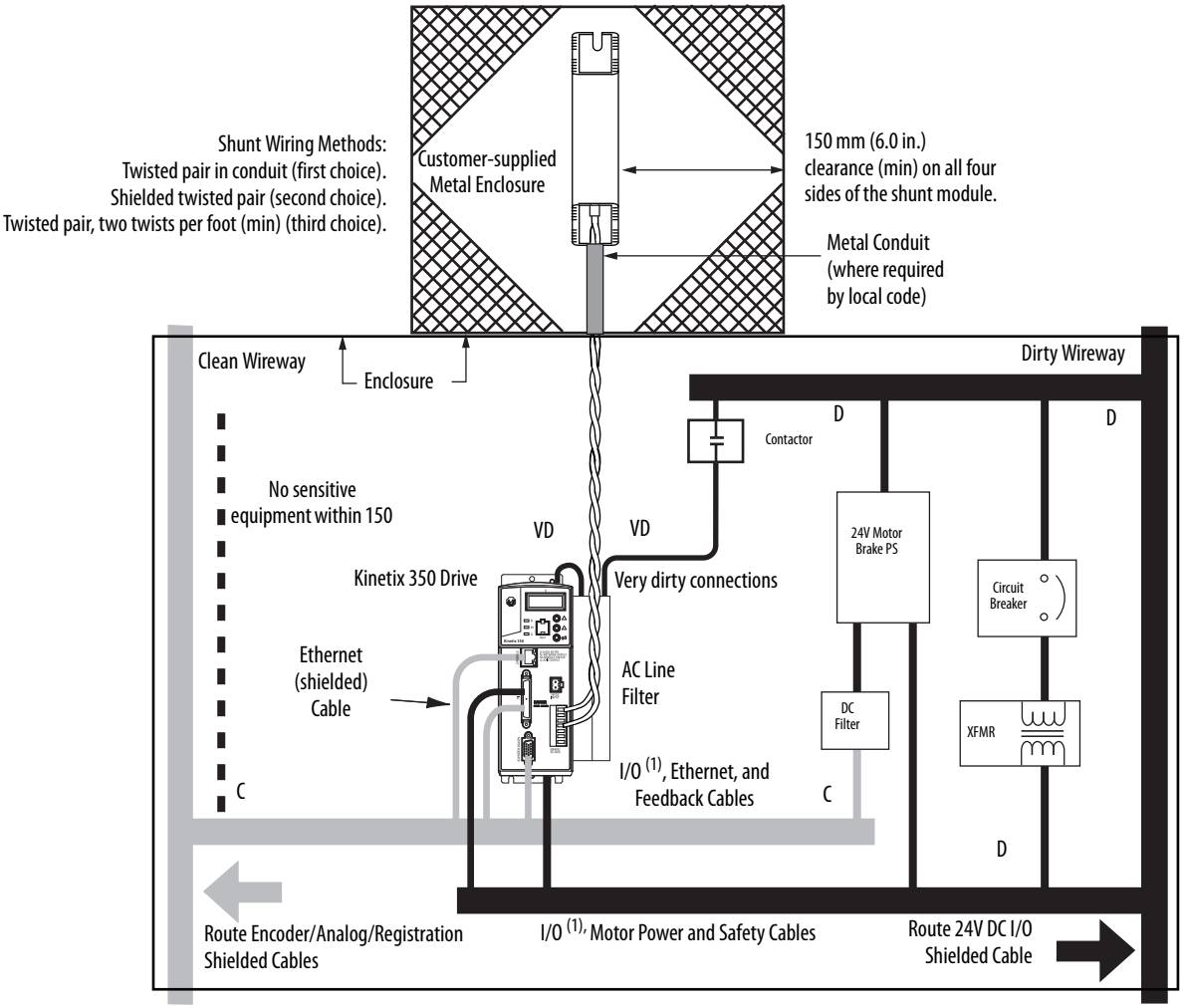
- Good HF bonding to the panel is critical. For painted panels, refer to the examples on page 21.
- Segregate input and output wiring as far as possible.

Shunt Resistors

Observe these guidelines when mounting your shunt resistor outside the enclosure:

- Mount shunt resistor and wiring in the very dirty zone or in an external shielded enclosure.
- Mount resistors in a shielded and ventilated enclosure outside the cabinet.
- Keep unshielded wiring as short as possible. Keep shunt wiring as flat to the cabinet as possible.

Figure 7 - Shunt Resistor Outside the Enclosure



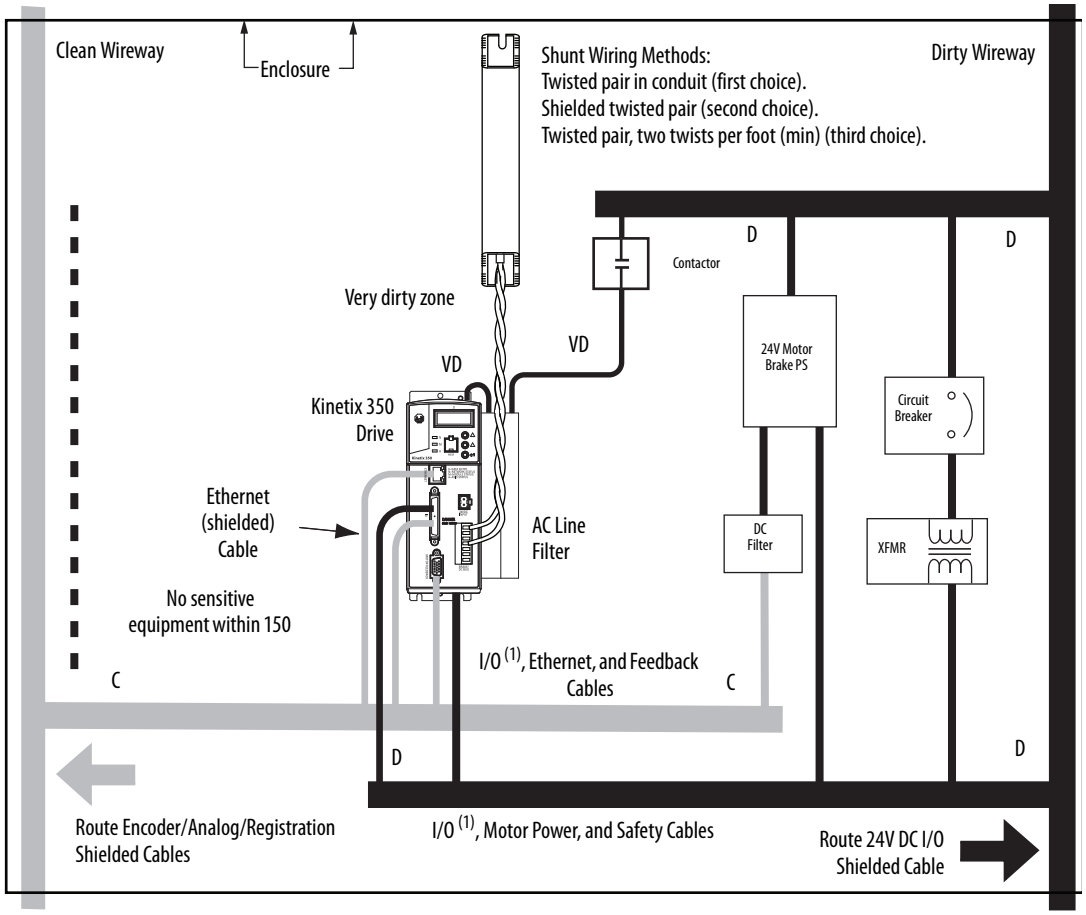
(1) If drive system I/O cable contains (dirty) relay wires, route cable in dirty wire way.

(2) When space does not permit 150 mm (6.0 in.) clearance, install a grounded steel shield between the drive and clean wireway. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

When mounting your shunt module inside the enclosure, follow these additional guidelines:

- Mount the shunt resistor anywhere in the dirty zone, but as close to the Kinetix 350 drive as possible.
- Shunt wires can be run with motor power cables.
- Keep unshielded wiring as short as possible. Keep shunt wiring as flat to the cabinet as possible.
- Separate shunt wires from other sensitive, low-voltage signal cables.

Figure 8 - Shunt Resistor inside the Enclosure



(1) If drive system I/O cable contains (dirty) relay wires, route cable in dirty wire way.
(2) When space does not permit 150 mm (6.0 in.) clearance, install a grounded steel shield between the drive and clean wireway. For examples, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

Motor Brake

The brake is mounted inside the motor and how you connect to the drive depends on the motor series.

Refer to Kinetix 350 Drive/Rotary Motor Wiring Examples beginning on page 146 for the interconnect diagram of your drive/motor combination.

Mount Your Kinetix 350 Drive

This procedure assumes you have prepared your panel and understand how to bond your system. For installation instructions regarding other equipment and accessories, refer to the instructions that came with those products.

ATTENTION: This drive contains electrostatic discharge (ESD) sensitive parts and assemblies. You are required to follow static control precautions when you install, test, service, or repair this assembly. If you do not follow ESD control procedures, components can be damaged. If you are not familiar with static control procedures, refer to Guarding Against Electrostatic Damage, publication 8000-4.5.2, or any other applicable ESD Protection Handbook.

Follow these steps to mount your Kinetix 350 drive.

1. Lay out the position for the Kinetix 350 drive and accessories in the enclosure.

   Refer to Establishing Noise Zones on page 23 for panel layout recommendations. Mounting hole dimensions for the Kinetix 350 drive are shown in Appendix A on page 127.

2. Attach the Kinetix 350 drive to the cabinet, first by using the upper mounting slots of the drive and then the lower.

   The recommended mounting hardware is M4 (#6-32) steel machine screws torqued to 1.1 N•m (9.8 lb•in). Observe bonding techniques as described in Bonding Drives on page 20.

   IMPORTANT To improve the bond between the Kinetix 350 drive and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

3. Tighten all mounting fasteners.

Kinetix 350 Drive Connector Data

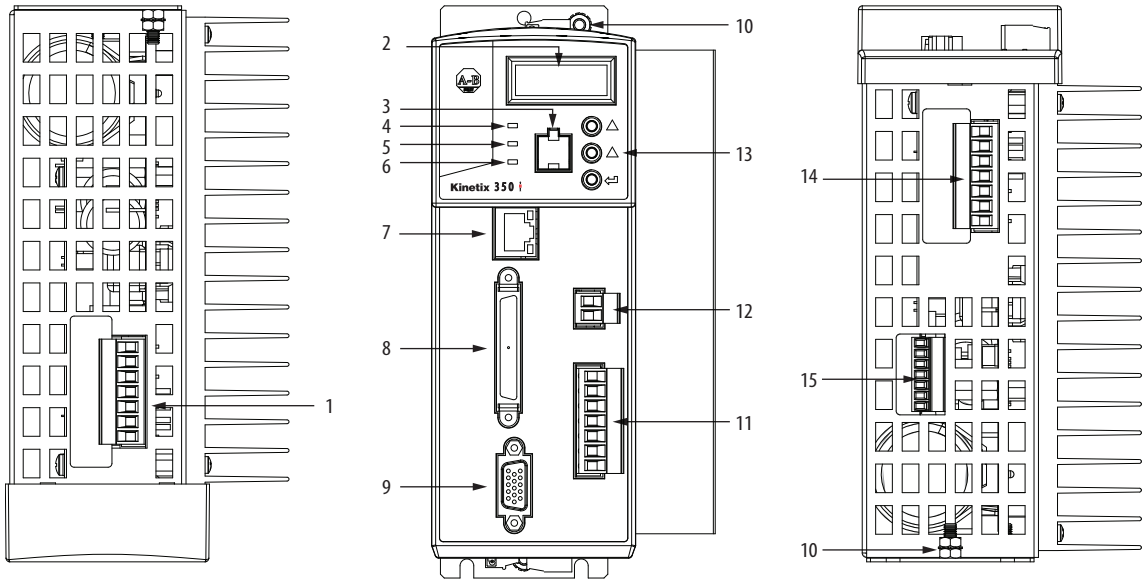
Introduction

This chapter provides power, feedback, and I/O connector locations and signal descriptions for your Kinetix 350 drive.

Kinetix 350 Drive Connectors and Indicators

Although the physical size of the Kinetix 350 drives vary, the location of the connectors and indicators is identical.

Figure 9 - Kinetix 350 Drive Connector and Indicators



Kinetix 350 Drive, Top View
(2097-V33PR5-LM drive is shown)

Kinetix 350 Drive, Front View
(2097-V33PR5-LM drive is shown)

Kinetix 350 Drive, Bottom View
(2097-V33PR5-LM drive is shown)

Item	Description
1	Mains (IPD) connector
2	Data status indicator and diagnostic display
3	Memory module socket
4	Network status indicator
5	Module status indicator
6	Axis status indicator
7	Ethernet communication port (Port 1)
8	I/O (IOD) connector

Item	Description
9	Motor feedback (MF) connector
10	Ground lug
11	Shunt resistor and DC bus (BC) connector
12	Back-up power (BP) connector
13	Display control push buttons (3)
14	Motor power (MP) connector
15	Safe torque-off (STO) connector

Table 6 - Kinetix 350 Drive Connectors

Designator	Description	Connector
IPD	AC input power	3-position or 4-position plug/header
PORT1	Ethernet communication port	RJ45 Ethernet
IOD	I/O	SCSI 50 pin high density connector
MF	Motor feedback	15-pin high-density D-shell (male)
BP	Back-up power	2-pin quick-connect terminal block
BC	Shunt Resistor and DC Bus	5-pin quick-connect terminal block
MP	Motor power	6-pin quick-connect terminal block
STO	Safe torque off (STO) Terminal	6-pin quick-connect terminal block

Safe Torque-off Connector Pinout

The Kinetix 350 drive ships with the (6-pin) wiring-plug header that connects your safety circuit to the Kinetix 350 drive safe torque-off (STO) connector. If your system does not use the safe torque-off feature, follow instructions in Safe Torque-off Feature Bypass starting on page 106 to wire the drive with motion-allowed jumpers.

Figure 10 - Safe Torque-off Connector

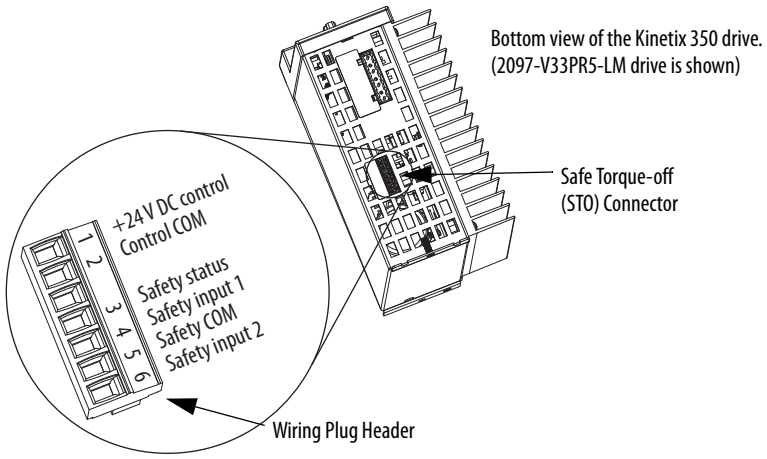


Table 7 - Kinetix 350 Drive Safe Torque-off Connector Pinout

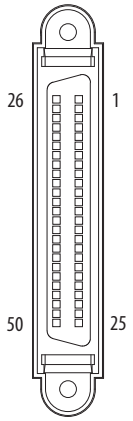
STO Pin	Description	Signal
1	+24V DC output from the drive	+24V DC control
2	+24V DC output common	Control COM
3	Safety status	Safety Status
4	Safety input 1 (+24V DC to enable)	Safety Input 1
5	Safety common	Safety COM
6	Safety input 2 (+24V DC to enable)	Safety Input 2

IMPORTANT Pins STO-1 (+24V DC Control) and STO-2 (Control COM) are used only by the motion-allowed jumpers to enable the drive when the safe torque-off function is not be used. When the safe torque-off function is in operation, the 24V supply must come from an external source.

I/O Connector Pinout

IOD Pin	Description	Signal
1…25	Reserved	Reserved
26	+/- Overtravel, enable, and home common	COM
27	Negative hardware overtravel	NEG_OT
28	Positive hardware overtravel	POS_OT
29	Drive enable	ENABLE
30	Home switch	HOME_SW
31…35	Reserved	—
36	Registration common	REG_COM
37…38	Reserved	—
39	Registration input	REG
40…42	Reserved	—
43	Motor brake release positive	MTR_BRAKE+
44	Motor brake release negative	MTR_BRAKE-
44…50	Reserved	—

Figure 11 - Pin Orientation for 50-pin SCSI I/O (IOD) Connector



Motor Feedback (MF) Connector Pinout

MF Pin	Description	Signal
1	Sine differential input+ AM+ differential input+	SIN+ AM+
2	Sine differential input- AM- differential input-	SIN- AM-
3	Cosine differential input+ BM+ differential input+	COS+ BM+
4	Cosine differential input- BM- differential input-	COS- BM-
5	Data differential input + Index pulse+	DATA+ IM+
6	Common	ECOM
7	Encoder power (+9V)	EPWR_9V (2)
8	Single-ended 5V Hall effect commutation	S3

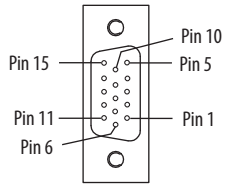
MF Pin	Description	Signal
9	Reserved	—
10	Data differential input - Index pulse-	DATA- IM-
11	Motor thermal switch (normally closed) (1)	TS
12	Single-ended 5V Hall effect commutation	S1
13	Single-ended 5V Hall effect commutation	S2
14	Encoder power (+5V)	EPWR_5V (2)
15	Reserved	—

(1) Not applicable unless motor has integrated thermal protection.

(2) Encoder power supply uses either 5V or 9V DC based on encoder/motor used.

IMPORTANT Drive-to-motor power and feedback cable length must not exceed 20 m (65.6 ft). System performance was tested at these specifications and also apply when meeting CE requirements.

Figure 12 - Pin Orientation for 15-pin Motor Feedback (MF) Connector

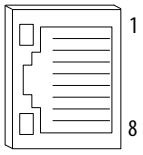


Ethernet Communication Connector Pinout

Port 1 Pin	Description	Signal
1	Transmit port (+) data terminal	+ TX
2	Transmit port (-) data terminal	- TX
3	Receive port (+) data terminal	+ RX
4	—	—

Port 1 Pin	Description	Signal
5	—	—
6	Receive port (-) data terminal	- RX
7	—	—
8	—	—

Figure 13 - Pin Orientation for 8-pin Ethernet Communication (port 1) Port



AC Input Power Connector Pinout

IPD Designator	Description (2097-V31PR*x*-LM drives)	Signal
L2/N	AC power in (non-doubler operation)	L2/N
L1	AC power in	L1
N	AC power neutral (120V doubler only)	N
PE	Protective earth (ground)	PE

IPD Designator	Description (2097-V32PR*x*-LM drives)	Signal
L2	AC power in	L2
L1	AC power in	L1
PE	Protective earth (ground)	PE

IPD Designator	Description (2097-V33PR*x*-LM, and 2097-V34PR*x*-LM drives)	Signal
L3	AC power in (three-phase models)	L3
L2	AC power in	L2
L1	AC power in	L1
PE	Protective earth (ground)	PE

Back-up Power Connector Pinout

BP Designator	Description	Signal
+24V	Positive 24V DC	+24V DC
-24V	24V DC power supply return	Return

Shunt Resistor and DC Bus Connector Pinout

BC Designator	Description	Signal
B+	Positive DC bus/Shunt resistor	B+
B+		B+
BR	Shunt resistor	BR
B-	Negative DC bus	B-
B-		B-

Motor Power Connector Pinout

MP Designator	Description	Signal
PE	Protective earth (ground)	PE
W	Motor power out	W
V	Motor power out	V
U	Motor power out	U

Control Signal Specifications

This section provides a description of the Kinetix 350 drive I/O (IOD), communication, shunt resistor and DC bus (BC), and back-up power (BP) connectors.

Digital Inputs

Five fixed inputs are available for the machine interface on the Kinetic 350 drive.

IMPORTANT To improve registration input EMC performance, refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

IMPORTANT Over-travel limit input devices must be normally closed.

The five digital inputs (IOD-27...IOD-30 and IOD-39) have fixed pin assignments.

Table 8 - Understanding Digital Inputs

IOD Pin	Signal	Description	Capture Time	Edge/Level Sensitive
IOD-29	ENABLE	Optically isolated, single-ended active high signal. Current loading is nominally 9 mA. A 24V DC input is applied to this terminal to enable the axis.	0.5 ms	Level
IOD-30	HOME	Optically isolated, single-ended active high signal. Current loading is nominally 9 mA. Home switch (normally open contact) inputs axis require 24V DC (nominal).	0.5 ms	Edge
IOD-39	REG	Fast registration inputs are required to inform the motor interface to capture the positional information with less than 5 µs uncertainty. Optically isolated, single-ended active high signal. Current loading is nominally 9 mA. A 24V DC input is applied to this terminal to enable axis.	5 µs	Edge
IOD-27 IOD-28	NEG_OT POS_OT	Overtravel detection is available as an optically isolated, single-ended active high signal. Current loading is nominally 9 mA per input. The positive/negative limit switch (normally closed contact) inputs for axis require 24V DC (nominal).	1 ms	Level

Table 9 - Understanding Digital Input Functions

Function	Description	Behavior
Enable	If the controller configuration specifies checking of the enable input, an active state enables the power electronics to control the motor and an inactive state prevents motion. The drive generates an exception if the input is inactive when the controller commands motion and has authorized checking. The drive behavior in this situation is programmable.	By default drive enable input checking is enabled. If the checking is authorized and the input is disabled the drive will issue a Drive Enable Start Inhibit and you will not be able to issue a Servo On instruction from the controller. To disable the Enable function: • Tie input to 24V DC • Write a RSlogix message instruction that changes enableInputChecking or Attribute 736 to zero, see instructions on page 98
Home	An active state indicates to a homing sequence that the referencing sensor has been seen. Typically, a transition of this signal is used to establish a reference position for the machine axis.	The function is always inactive unless armed by the controller.
Registration	An inactive-to-active transition (also known as a positive transition) or active-to-inactive transition (also known as a negative transition) is used to latch position values for use in registration moves.	
Positive Over-travel	If the controller configuration specifies checking of the hardware over-travel inputs, an inactive state indicates that a position limit has been exceeded in the positive direction. The drive generates an exception if the input is inactive when the controller authorizes checking. The drive behavior in this situation is programmable.	The function is always active. To disable function: • Tie input to 24V • Set to Fault Status Only
Negative Over-travel	If the controller configuration specifies checking of the hardware overtravel inputs, an inactive state indicates that a position limit has been exceeded in the negative direction. The drive generates an exception if the input is inactive when the controller authorizes checking. The drive behavior in this situation is programmable.	

Table 10 - Digital Input Specifications

Attribute	Value
Type	Active high, single-ended, current sinking
Functions	Enable, Home, Positive Over-travel, Negative Over-travel, Registration
Input current (with 24V applied)	9 mA, max
On-state input voltage	4.2…24V @ 2…9 mA total
Off-state input voltage	0…2.5V
Pulse reject filtering (Registration functions only)	120 ns, nom
Pulse reject filtering, default (all other input functions, can be configured)	1.0 ms, nom
Propagation delay (Registration function only)	5 µs
Registration repeatability	200 ns
Input reaction time (Disable)	2 ms, max
Input reaction time (Enable, Positive Over-travel inputs)	2 ms, max

The digital inputs are optically isolated and sinks up to 24V DC. Electrical details are shown in Table 9 on page 36. You can set up the inputs for PNP sourcing or NPN sinking.

Figure 14 - Sourcing of Digital Inputs

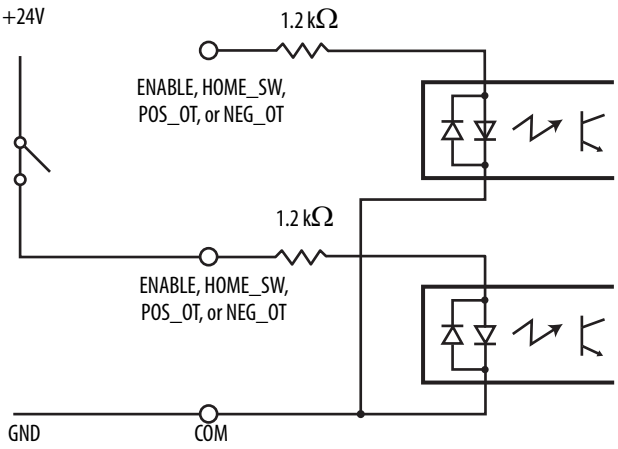


Figure 15 - Sinking of Digital Inputs

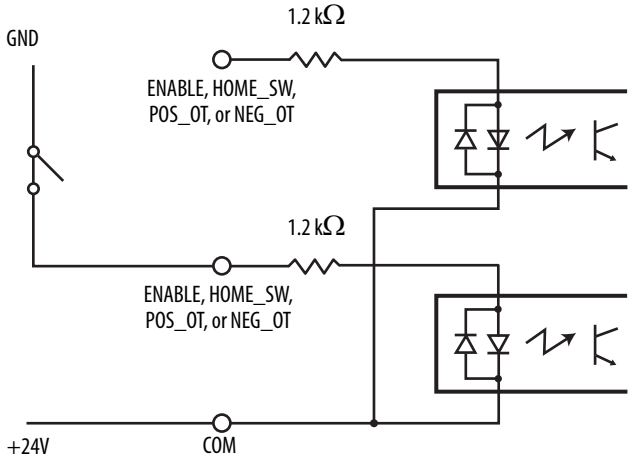


Figure 16 - Sourcing of Registration Digital Input

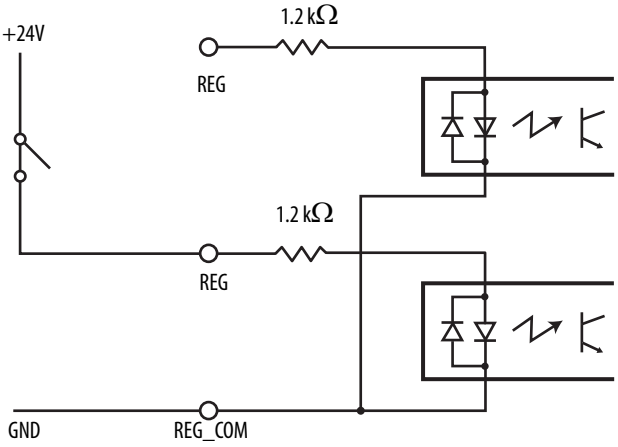
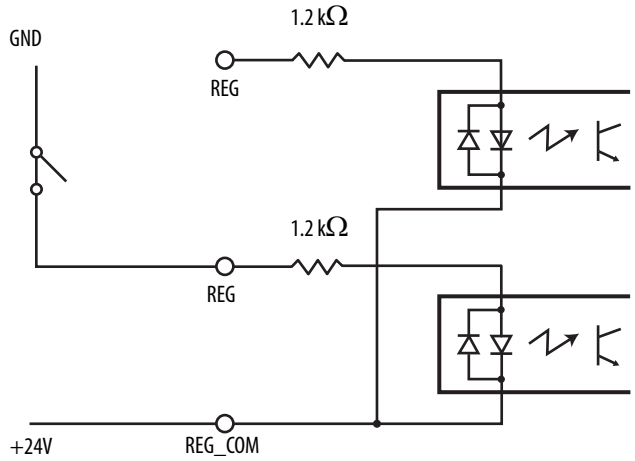
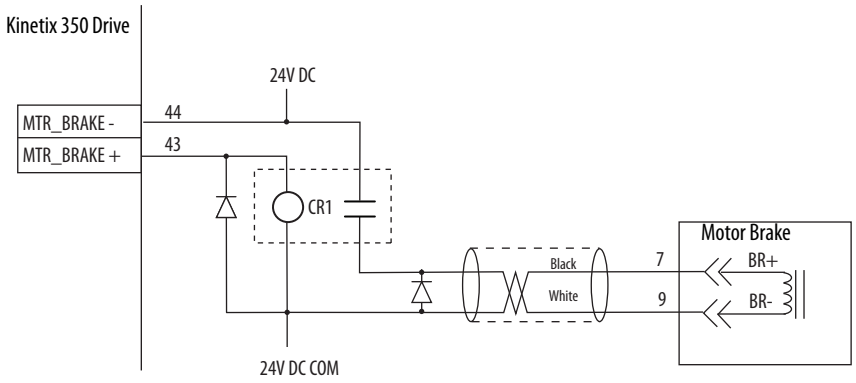


Figure 17 - Sinking of Registration Digital Input



Motor Brake Output

The two digital outputs (IOD-43 and IOD-44) have fixed pin assignments for motor brake function. The following schematic show how to wire your motor brake.



Use these guideline to wire your brake:

- Connect a diode, 1N4004 or equivalent, as shown on both the rely and the motor brake coils.
- Wire the output as sourcing.
- The motor brake output is active on enable.
- Set the motor engage and disengage times based on the motor selected.

Ethernet Communication Specifications

An RJ45 100 Mbit Ethernet connector (port 1) is provided on the Kinetix 350 drive. It is fully compliant to the EtherNet/IP standard. Restrict the location of all Ethernet cabling to clean zones with minimal electromagnetic interference.

Attribute	Value
Communication	100BASE-TX, full duplex
Auto MDI/MDIX crossover detection/correction	Yes
Cabling	Rockwell Automation CAT5E shielded, 100 m (328 ft), max

24V DC Back-up Power Specifications

The Kinetix 350 drive can use an external power supply to power the logic and communication circuits. If an independent 24V (@ 1 A) power supply is connected to the BP connector, the logic and communication circuits remain active during a mains input power loss.

Attribute	Value
Input voltage	20…26V DC
Current	500 mA
Inrush, max	30 A

Motor Feedback Specifications

The drive accepts motor feedback signals from the following types of encoders with these general specifications.

Table 11 - Motor Feedback General Specifications

Attribute	Value
Feedback device support	• Stegmann Hiperface • Generic TTL Incremental • Tamagawa 17-bit Serial
Power supply (EPWR5V)	5.13…5.67V, 400 mA, max
Power supply (EPWR9V)	8.3…9.9V, 275 mA, max
Thermostat	Single-ended, under 500 Ω = no fault, over 10 kΩ = fault

The Kinetix 350 drives support multiple types of feedback devices by using the 15-pin (MF) motor feedback connector and sharing connector pins in many cases.

Table 12 - Motor Feedback Signals by Device Type

MF Pin	Stegmann Hiperface	Generic TTL Incremental	Tamagawa 17-bit Serial
1	SIN+	AM+	—
2	SIN-	AM-	—
3	COS+	BM+	—
4	COS-	BM-	—
5	DATA+	IM+	DATA+
6	ECOM	ECOM	ECOM
7	EPWR9V	—	—
8	—	S3	—
9	—	—	—
10	DATA-	IM-	DATA-
11	TS	TS	TS
12	—	S1	—
13	—	S2	—
14	EPWR5V	EPWR5V	EPWR5V
15	—	—	—

This is the motor thermostat interface schematic. Although the thermostat signal is shown for all feedback types, some motors may not support this feature because it is not part of the feedback device.

Figure 18 - Motor Thermostat Interface

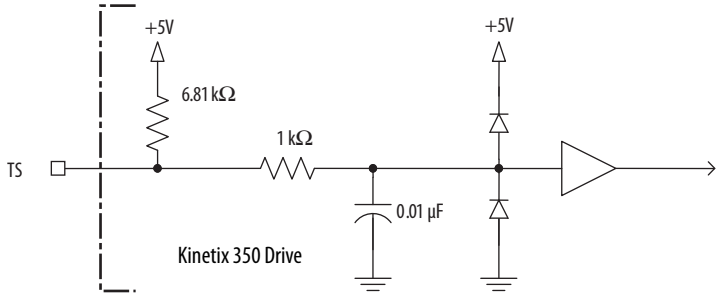


Table 13 - Motor Thermostat State Specifications

State	Resistance at TS (1)
No Fault	500 Ω
Fault	10 kΩ

(1) Resistance is measured between TS (MF pin 11) and ECOM (MF pin 6)

Table 14 - Stegmann Hiperface Specifications

Attribute	Value
Protocol	Hiperface
Memory support	Not programmed, or programmed with Allen-Bradley motor data
Hiperface data communication	RS485, 9600 bps, 8 data bits, no parity
Sine/Cosine interpolation	2048 counts/sine period
Input frequency (AM/BM)	250 kHz, max
Input voltage (AM/BM)	0.6...1.2V, p-p, measured at the drive inputs
Line loss detection (AM/BM)	Average ($sin^2 + cos^2$) > constant

Figure 19 - Stegmann Hiperface Interface, SIN and COS Signals

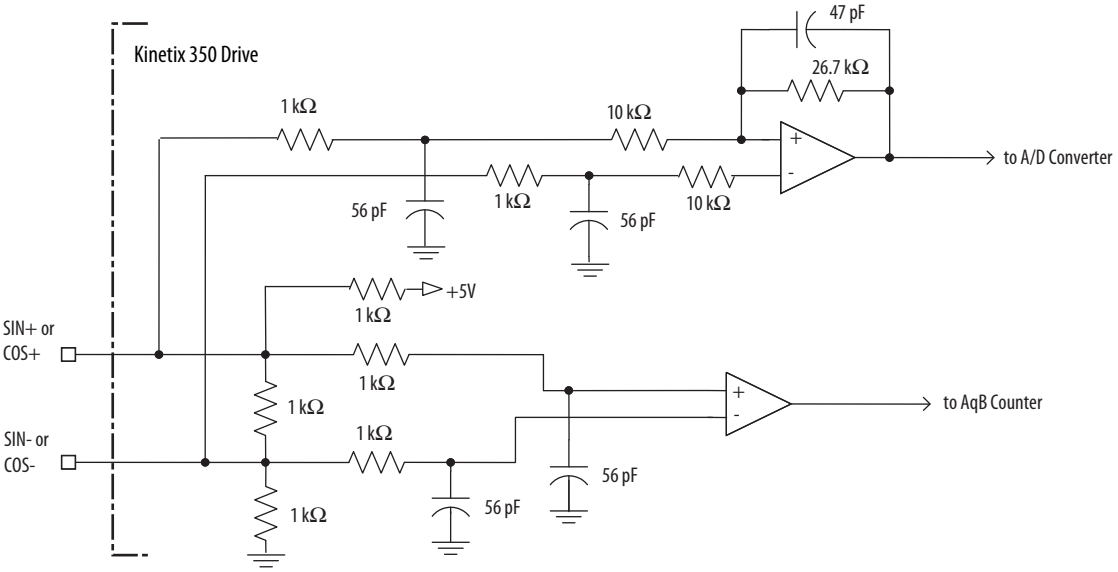


Figure 20 - Stegmann Hiperface Interface, DATA Signals

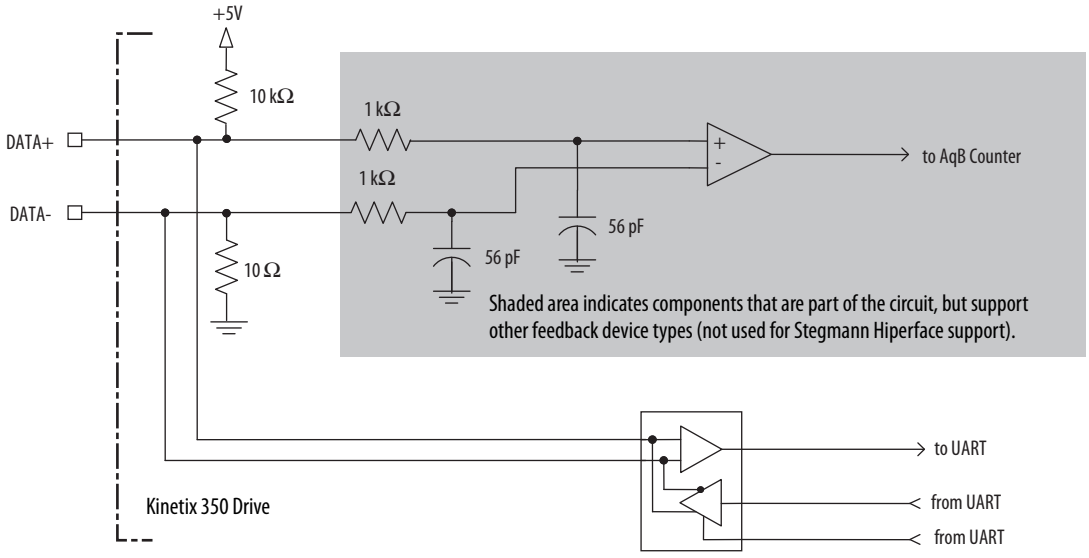


Table 15 - Generic TTL Incremental Specifications

Attribute	Value
TTL incremental encoder support	5V, differential A quad B
Quadrature interpolation	4 counts/square wave period
Differential input voltage (AM, BM, and IM)	1.0…7.0V
DC current draw (AM, BM, and IM)	30 mA, max
Input signal frequency (AM, BM, and IM)	5.0 MHz, max
Edge separation (AM and BM)	42 ns min, between any two edges
Line loss detection (AM and BM)	Average ($AM^2 + BM^2$) > constant
Hall inputs (S1, S2, and S3)	Single-ended, TTL, open collector, or none

Figure 21 - Generic TTL Incremental, AM and BM Signals

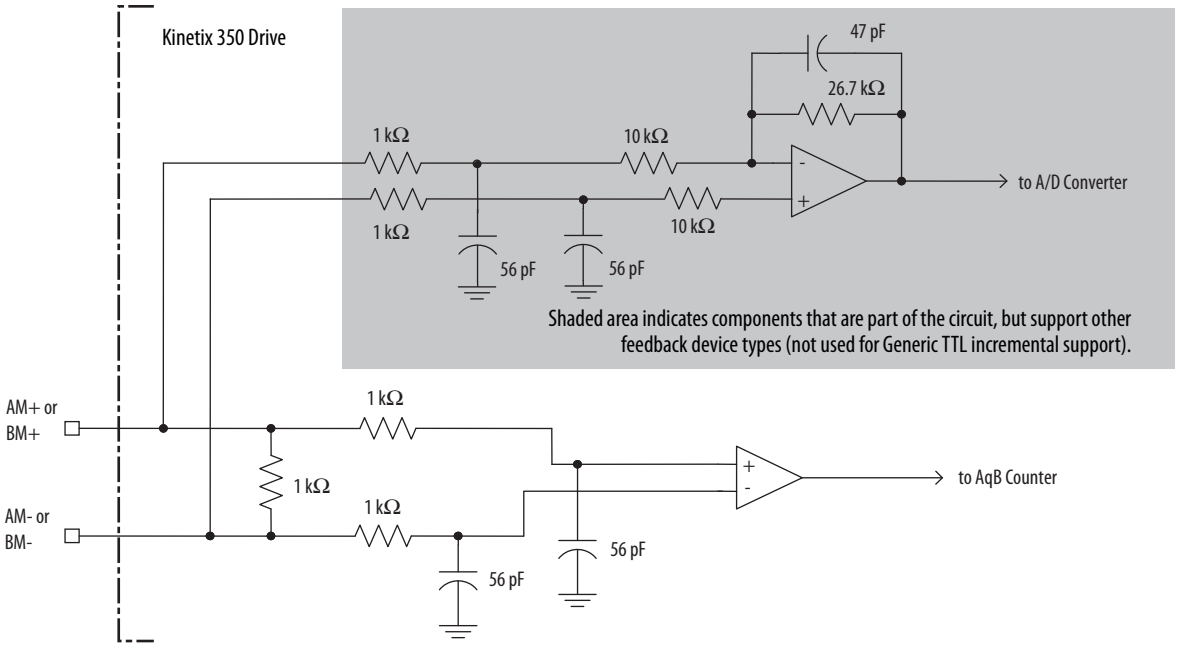


Figure 22 - Generic TTL Interface, IM Signals

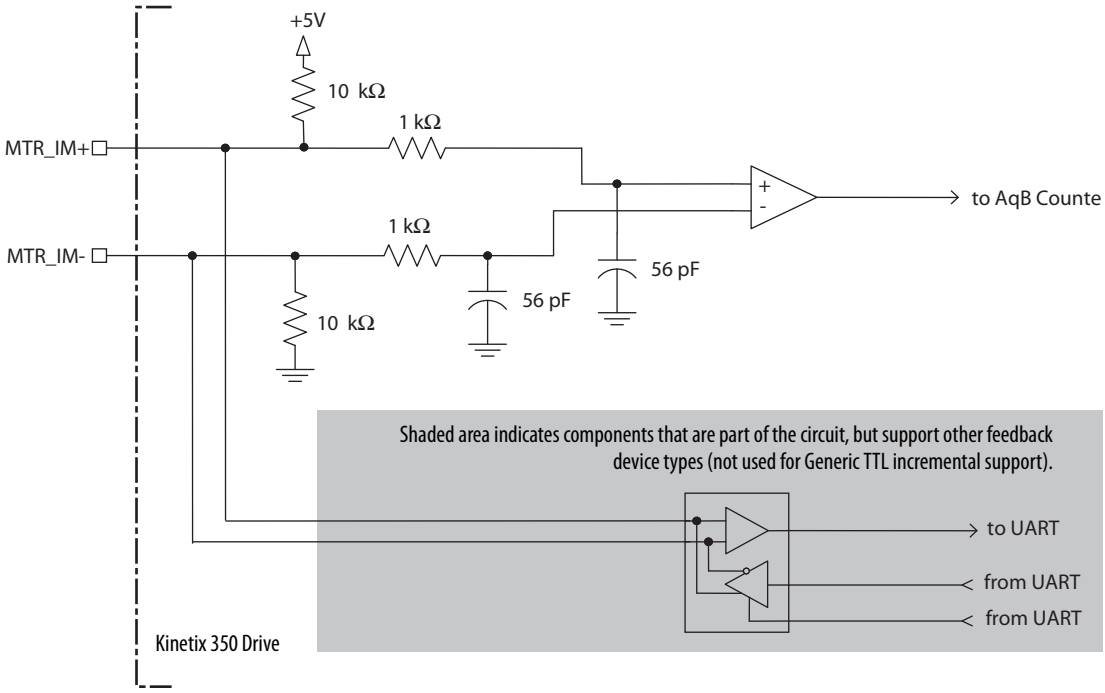


Figure 23 - Generic TTL Interface, S1, S2, or S3 Signals

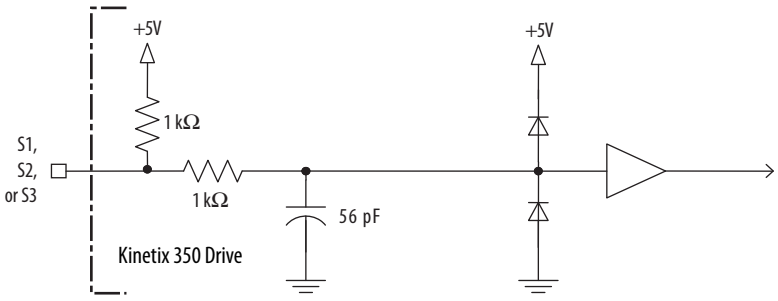


Table 16 - Tamagawa 17-bit Serial Specifications

Attribute	Value
Tamagawa model support	TS5669N124
Protocol	Tamagawa proprietary
Memory support	Programmed with Allen-Bradley motor data
Differential input voltage	1.0…7.0V
Data communication	2.5 Mbps, 8 data bits, no parity
Battery	3.6V, located external to drive in low-profile connector kit

Refer to Figure 20 for the Tamagawa 17-bit serial interface schematic. It is identical to the Stegmann Hiperface (DATA) signals schematic.

Feedback Power Supply

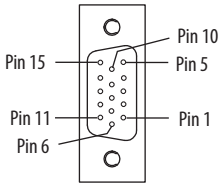
The Kinetix 350 drive generates +5V and +9V DC for motor feedback power. Short circuit protection and separate common mode filtering for each channel is included.

Table 17 - Motor Feedback Power Specifications

Supply	Reference	Voltage			Current mA	
		Min	Nominal	Max	Min	Max
+5V DC	EPWR_5V	5.13	5.4	5.67	0	400 (1) (2)
+9V DC	EPWR_9V	8.3	9.1	9.9	0	275 (2) (3)

(1) 400 mA on the 5V supply with no load on the 9V supply.
(2) 300 mA on the 5V supply with 150 mA on the 9V supply.
(3) 275 mA on the 9V supply with no load on the 5V supply.

Figure 24 - Pin Orientation for 15-pin Motor Feedback (MF) Connector



Notes:

Connect the Kinetix 350 Drive System

Introduction

This chapter provides procedures for wiring your Kinetix 350 system components and making cable connections.

Basic Wiring Requirements

This section contains basic wiring information for the Kinetix 350 drive.

ATTENTION: Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

SHOCK HAZARD: To avoid hazard of electrical shock, perform all mounting and wiring of the Bulletin 2097 drive prior to applying power. Once power is applied, connector terminals may have voltage present even when not in use.

IMPORTANT This section contains common PWM servo system wiring configurations, size, and practices that can be used in a majority of applications. National Electrical Code, local electrical codes, special operating temperatures, duty cycles, or system configurations take precedence over the values and methods provided.

Recommended Cables

The Motor Power Cable Compatibility table on page 62 and Motor Feedback Cables for Specific Motor/Feedback Combinations table on page 67 show the cables Rockwell Automation recommends you use with the Kinetix 350 drive.

IMPORTANT Factory-made cables are designed to minimize EMI and are recommended over hand-built cables to optimize system performance.

If it is necessary for you to build or modify your own cable, follow these guidelines:

- Connect the cable shield to the connector shells on both ends of the cable with a complete 360° connection.
- Use twisted pair cable whenever possible. Twist differential signals with each other and twist single-ended signals with the appropriate ground return.

Refer to the Kinetix Motion Control Selection Guide, publication GMC-SG001, for low-profile connector kit, drive-end (mating) connector kit, and motor-end connector kit catalog numbers.

Route Power and Signal Wiring

Be aware that when you route power and signal wiring on a machine or system, radiated noise from nearby relays, transformers, and other electronic drives can be induced into motor or encoder feedback signals, input/output communication, or other sensitive low voltage signals. This can cause system faults and communication anomalies.

Refer to Electrical Noise Reduction on page 20 for examples of routing high and low voltage cables in wireways. Refer to the System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001, for more information.

Determine the Input Power Configuration

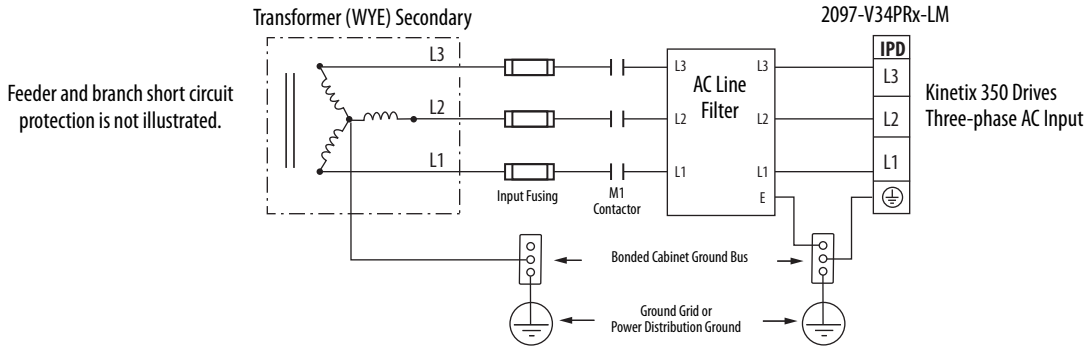
This section contains examples of typical single-phase and three-phase facility input power wired to single-phase and three-phase Kinetix 350 drives.

The grounded power configuration lets you ground your single-phase or three-phase power at a neutral point. Match your secondary to one of the examples and be certain to include the grounded neutral connection.

Three-phase Power Wired to Three-phase Drives

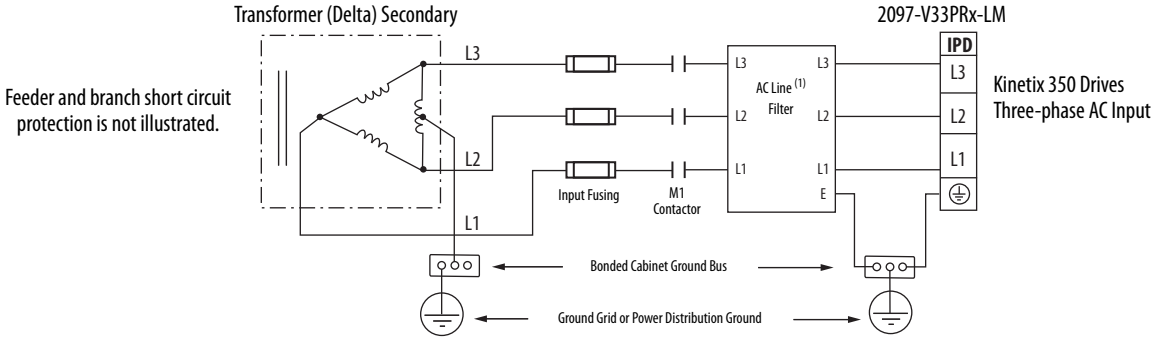
These examples illustrate grounded three-phase power wired to three-phase Kinetix 350 drives when phase-to-phase voltage is within drive specifications.

Figure 25 - Three-phase (400/480V) Power Configuration (WYE secondary)



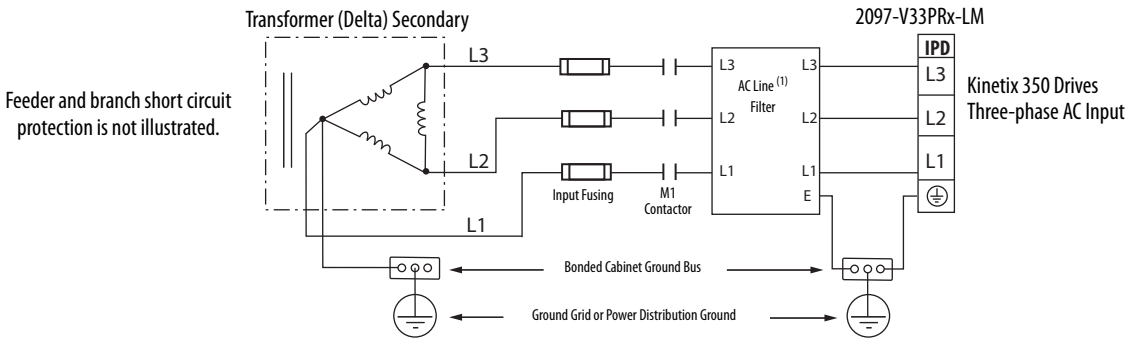
IMPORTANT For the 480V Kinetix 350 drives to meet proper voltage creepage and clearance requirements, each phase voltage to ground must be less than or equal to 300V AC rms. This means that the power system must use center grounded wye secondary configuration for 400/480V AC mains.

Figure 26 - Three-phase (240V) Power Configuration (Delta secondary)



(1) Leakage current from the line filter, in this configuration, typically is higher than a balanced (center ground) configuration.

Figure 27 - Three-phase (240V) Power Configuration (Delta secondary)



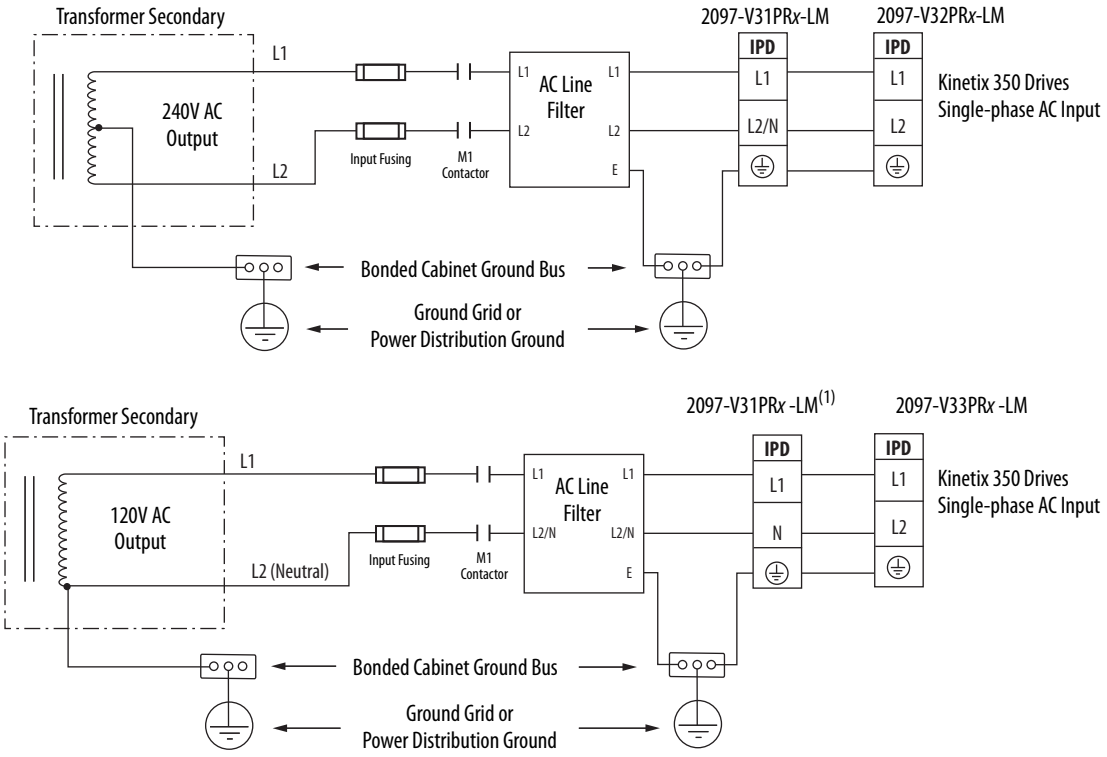
(1) Leakage current from the line filter, in this configuration, typically is higher than a balanced (center ground) configuration.

Single-phase Power Wired to Single-phase Drives

These examples illustrate grounded single-phase power wired to single-phase Kinetix 350 drives when phase-to-phase voltage is within drive specifications.

IMPORTANT The 2097-V32PRx-LM models have integrated AC line filters and do not require the AC line filter shown in this diagram.

Figure 28 - Single-phase Grounded Power Configurations



(1) This configuration applies to voltage-doubler operation for 2097-V31PRx-LM drives.

Reducing transformer output reduces motor speed. Feeder and branch short circuit protection is not illustrated.

Voltage Doubler Operation

You can wire the 2097-V31PRx-LM drives with 120V input voltage and achieve twice the output voltage. To use the voltage-doubler circuit, connect the 120V single-phase input power to the IPD-L1 and IPD-N terminals.

For Kinetix 350 drive power specifications, refer to Kinetix 350 Drive Power Specifications on page 128. For Kinetix 350 drive input wiring diagrams, refer to Power Wiring Examples on page 141.

Isolation Transformer in Grounded Power Configurations

When using an isolation transformer, attach a chassis ground wire to the neutral connection. This grounded neutral connection does the following:

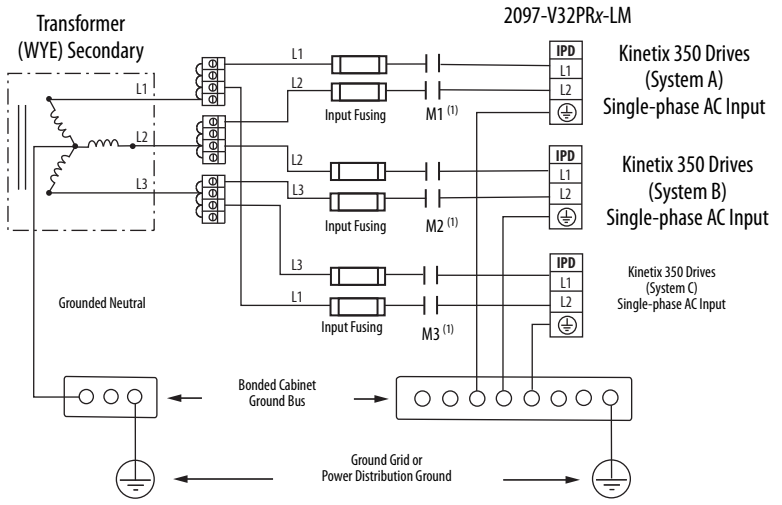
- Prevents the system from floating and thereby avoids any high voltages that might otherwise occur, for example due to static electricity
- Provides a solid earth path for fault conditions

ATTENTION: If the supply transformer is an auto transformer (not recommended), do not add a chassis earth ground. A chassis earth ground should already be included elsewhere in the system and adding another would create a short.

Three-phase Power Wired to Single-phase Drives

This example illustrates grounded three-phase power wired to single-phase Kinetix 350 drives when phase-to-phase voltage is within drive specifications.

Figure 29 - Single-phase Amplifiers on Three-phase Power (WYE)



(1) Contactors (MI, M2, and M3) may be optional. For more information, refer to Understanding the Machinery Directive, publication SHB-900. AC line filter is optional, but is required for CE compliance.

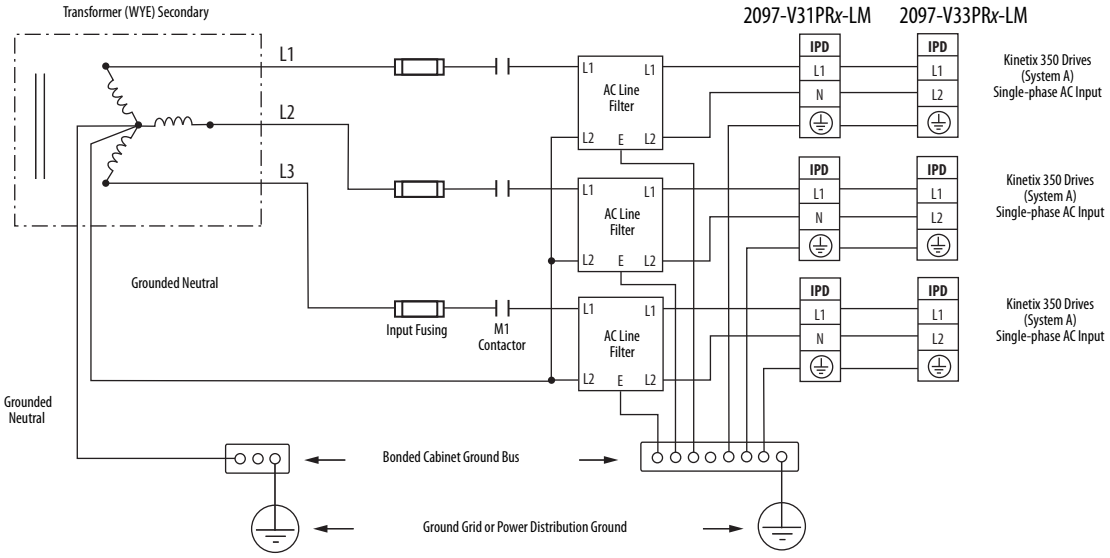
Feeder short circuit protection is not illustrated.

This example illustrates grounded three-phase power wired to single-phase Kinetix 350 drives when phase-to-phase voltage exceeds drive specifications.

A neutral must be connected when single-phase drives are attached to a three-phase isolating transformer secondary. It is not necessary that all three-phases be loaded with drives, but each drive must have its power return via the neutral connection.

ATTENTION: Failure to connect the neutral can result in supply voltage swings at the individual drives. This occurs when the neutral point moves vectorially as a result of load variations normally experienced by the individual drives. The supply voltage swing may cause undervoltage and overvoltage trips on the drives, and the drive can be damaged if the overvoltage limit is exceeded.

Figure 30 - Single-phase Amplifiers (one AC line filter per drive)



Feeder and branch short circuit protection is not illustrated.

IMPORTANT Providing an AC line filter for each drive is the preferred configuration and required for CE compliance.

Voiding of CE Compliance

The three-phase and neutral in-line filter applications described above may not be adequate from an EMC aspect for CE compliance. Therefore, EMC validity and CE marking by Rockwell Automation is voided when three-phase and neutral in line filters are used.

ATTENTION: The three-phase isolation transformer and neutral in-line filter applications described in this document have not been tested for EMC by Rockwell Automation and products used in such installations are not considered CE marked by Rockwell Automation.

If this three-phase isolation transformer and neutral in-line filter application is used, the responsibility for EMC validation lies with the user and CE marking of the system becomes the user's responsibility.

If CE compliance is a customer requirement, single-phase line filters that have been tested by Rockwell Automation and specified for the product should be used. Refer to AC Line Filter Specifications on page 135 for catalog numbers.

Grounding Your Kinetix 350 Drive System

All equipment and components of a machine or process system should have a common earth ground point connected to their chassis. A grounded system provides a safety ground path for short circuit protection. Grounding your modules and panels minimize shock hazard to personnel and damage to equipment caused by short circuits, transient overvoltages, and accidental connection of energized conductors to the equipment chassis. For CE grounding requirements, refer to CE Requirements in Chapter 1.

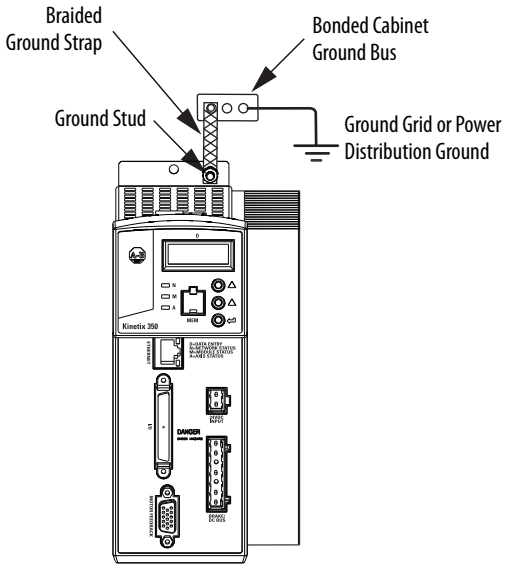
IMPORTANT To improve the bond between the Kinetix 350 drive and subpanel, construct your subpanel out of zinc plated (paint-free) steel.

Ground Your Drive to the System Subpanel

ATTENTION: The National Electrical Code contains grounding requirements, conventions, and definitions. Follow all applicable local codes and regulations to safely ground your system. Refer to the illustration below for details on grounding your Kinetix 350 drive. Refer to Appendix B for the power wiring diagram for your Kinetix 350 drive.

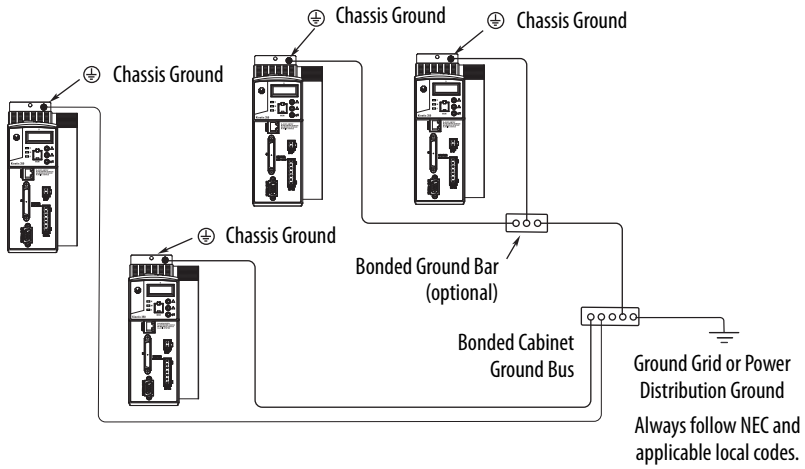
If the Kinetix 350 drive is mounted on a painted subpanel, ground the drive to a bonded cabinet ground bus by using a braided ground strap or 4.0 mm^2 (12 AWG) solid copper wire 100 mm (3.9 in.) long.

Figure 31 - Connecting the Braided Ground Strap Example



For drive dimensions, refer to Product Dimensions on page 137.

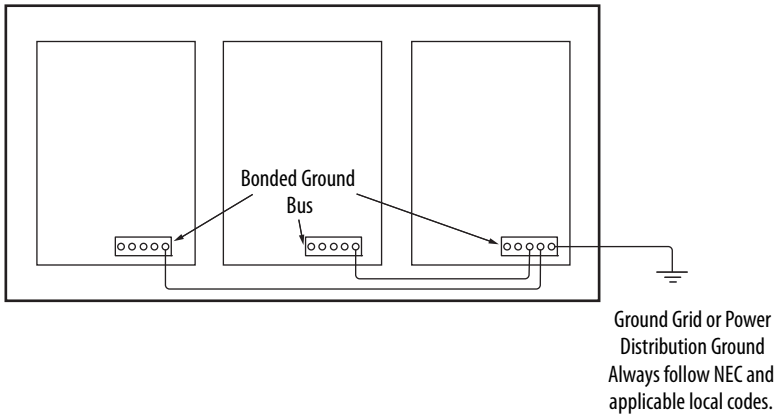
Figure 32 - Chassis Ground Configuration (multiple Kinetix 350 drives on one panel)



Ground Multiple Subpanels

To ground multiple subpanels, refer to the figure below. HF bonding is not illustrated. For information, refer to Bonding Multiple Subpanels on page 22.

Figure 33 - Subpanels Connected to a Single Ground Point



Power Wiring Requirements

Wire should be copper with 75 °C (167 °F) minimum rating. Phasing of main AC power is arbitrary and an earth ground connection is required for safe and proper operation.

Refer to Power Wiring Examples on page 143 for interconnect diagrams.

IMPORTANT The National Electrical Code and local electrical codes take precedence over the values and methods provided.

Table 18 - Kinetix 350 Drive Power Wiring Requirements

Cat. No.	Description	Terminals				Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
		Pins	Signals					
2097-V31PR0-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V33PR1-LM 2097-V33PR3-LM 2097-V34PR3-LM 2097-V34PR5-LM 2097-V34PR6-LM	Mains input power (IPD connector)		L3 L2 L1 PE (1)	L2/N L1 N PE (2)	L2 L1 PE (3)	Motor power cable depends on motor/drive combination. 2.5 (14)	7 (0.28)	0.5 (4.5)
2097-V32PR4-LM 2097-V33PR5-LM						4.0 (12)	7 (0.28)	0.5 (4.5)
2097-V31PR2-LM 2097-V33PR6-LM						6.0 (10)	7 (0.28)	0.56…0.79 (5.0…7.0)
2097-V31PR0-LM 2097-V31PR2-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V32PR4-LM 2097-V33PR1-LM 2097-V33PR3-LM 2097-V33PR5-LM 2097-V34PR3-LM 2097-V34PR5-LM 2097-V34PR6-LM	Motor power (MP connector)		PE W V U			2.5 (14)	7 (0.28)	0.5 (4.5)
2097-V33PR6-LM						4.0 (12)	7 (0.28)	0.5 (4.5)
2097-V31PR0-LM 2097-V31PR2-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V32PR4-LM 2097-V33PR1-LM 2097-V33PR3-LM 2097-V33PR5-LM 2097-V34PR3-LM 2097-V34PR5-LM 2097-V34PR6-LM	Brake /DC Bus (4) (BC connector)		B+ B+ BR B- B-			2.5 (14)	7 (0.28)	0.5 (4.5)
2097-V33PR6-LM						4.0 (12)	7 (0.28)	0.5 (4.5)
2097-V3*x*PR*x*-LM	Control back-up power (BP connector)		+24V DC -24V DC			1.5 (16)	6 (0.25)	0.5 (4.5)
2097-V3*x*PR*x*-LM	Safe torque-off (STO connector)	STO-1 (5) STO-2 (5) STO-3 STO-4 STO-5 STO-6	+24V DC Control Control COM Safety Status Safety Input 1 Safety COM Safety Input 2					

(1) Applies to 2097-V33PR*x*-LM, and 2097-V34PR*x*-LM drive modules.

(2) Applies to 2097-V31PR*x*-LM drive modules.

(3) Applies to 2097-V32PR*x*-LM drive modules.

(4) Use for shunt resistor connection only.

(5) Use for bypassing the STO circuit only.

ATTENTION: To avoid personal injury and/or equipment damage, make sure installation complies with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment.

To avoid personal injury and/or equipment damage, make sure motor power connectors are used for connection purposes only. Do not use them to turn the unit on and off.

To avoid personal injury and/or equipment damage, make sure shielded power cables are grounded to prevent potentially high voltages on the shield.

Table 19 - Shunt Resistor Power Wiring Requirements

Accessory	Description	Connects to Terminals	Recommended Wire Size mm^2 (AWG)	Torque Value N•m (lb•in)
2097-R*x*	Shunt Resistor	B+	2.5 (14)	0.5 (4.5)
		BR		

Wiring Guidelines

Use these guidelines as a reference when wiring the connectors on your Kinetix 350 drive power modules.

IMPORTANT For connector locations of the Kinetix 350 drives, refer to Kinetix 350 Drive Connectors and Indicators on page 30.

When tightening screws to secure the wires, refer to the tables beginning on page 55 for torque values.

When removing insulation from wires, refer to the tables beginning on page 55 for strip lengths.

IMPORTANT To improve system performance, run wires and cables in the wireways as established in Establishing Noise Zones on page 23.

Follow these steps when wiring the connectors on your Kinetix 350 drive modules.

1. Prepare the wires for attachment to each connector plug by removing insulation equal to the recommended strip length.

   IMPORTANT Use caution not to nick, cut, or otherwise damage strands as you remove the insulation.

2. Route the cable/wires to your Kinetix 350 drive.
3. Insert wires into connector plugs.

   Refer to connector pinout tables in Chapter 3 or the interconnect diagrams in Appendix B.
4. Tighten the connector screws.
5. Gently pull on each wire to make sure it does not come out of its terminal; reinsert and tighten any loose wires.
6. Insert the connector plug into the module connector.

Wiring the Kinetix 350 Drive Connectors

This section provides examples and wiring tables to assist you in making connections to the Kinetix 350 drive.

Wire the Safe Torque-off (STO) Connector

For the safe torque-off (STO) connector pinouts, feature descriptions, and wiring information, refer to Chapter 6 on page 99.

Wire the Back-up Power (BP) Connector

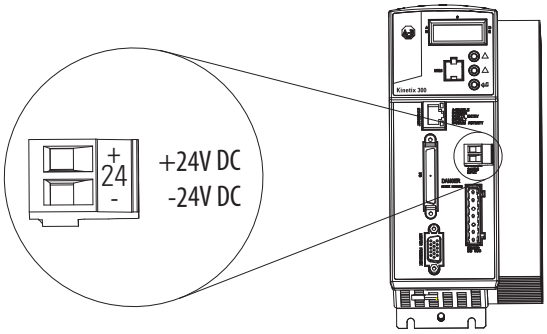


Table 20 - Back-up Power (BP) Connector

Drive Cat. No.	Terminals	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2097-V3xPRx-LM	+24V DC	1.5 (16)	6 (0.25)	0.5 (4.5)
	-24V DC			

Wire the Input Power (IPD) Connector

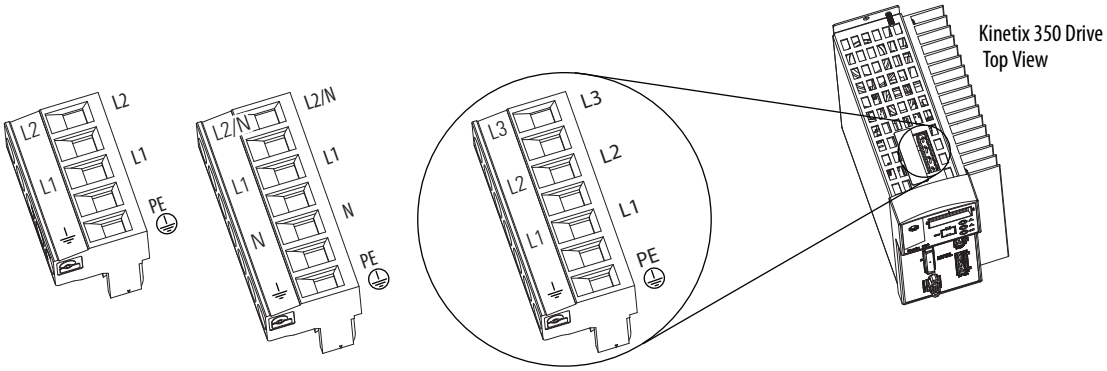


Table 21 - Input Power (IPD) Connector

Drive Cat. No.	Terminals			Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2097-V31PR0-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V33PR1-LM 2097-V33PR3-LM 2097-V34PR3-LM 2097-V34PR5-LM 2097-V34PR6-LM	L3 L2 L1 PE (1)	L2/N L1 N PE (2)	L2 L1 PE (3)	2.5 (14)	7 (0.28)	0.5 (4.5)
2097-V32PR4-LM 2097-V33PR5-LM				4.0 (12)	7 (0.28)	0.5 (4.5)
2097-V31PR2-LM 2097-V33PR6-LM				6.0 (10)	7 (0.28)	0.56…0.79 (5.0…7.0)

(1) Applies to 2097-V33PR*x*-LM, and 2097-V34PR*x*-LM drive modules.

(2) Applies to 2097-V31PR*x*-LM drive modules.

(3) Applies to 2097-V32PR*x*-LM drive modules.

Wire the Motor Power (MP) Connector

Connections to the motor power (MP) connector include rotary motors and rotary motor driven actuators.

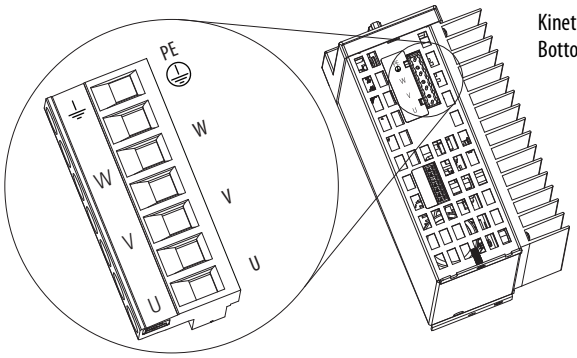


Table 22 - Motor Power (MP) Termination Specifications

Drive Cat. No.	Terminals	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2097-V31PR0-LM 2097-V31PR2-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V32PR4-LM 2097-V33PR1-LM 2097-V33PR3-LM 2097-V33PR5-LM 2097-V34PR3-LM 2097-V34PR5-LM 2097-V34PR6-LM	PE W V U	2.5 (14)	7 (0.28)	0.5 (4.5)
2097-V33PR6-LM		4.0 (12)		

Cable Shield Terminations

Factory-supplied motor power cables for MP-Series™ and TL-Series™ motors and actuator are shielded. The braided cable shield must terminate near the drive during installation. Remove small portion of the cable jacket to expose the shield braid and clamp the exposed shield to the panel.

ATTENTION: To avoid hazard of electrical shock, ensure shielded power cables are grounded at a minimum of one point for safety.

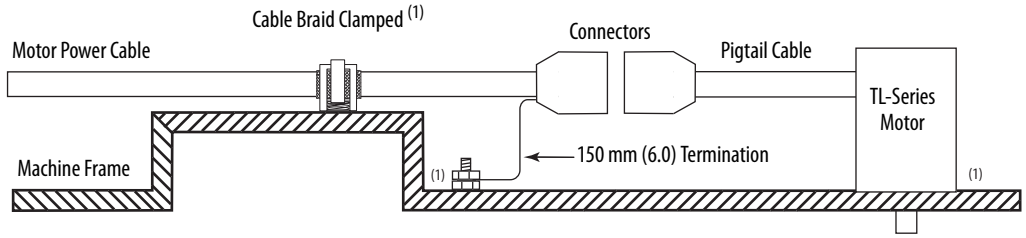
IMPORTANT For TL-Series motors, also connect the 152 mm (6.0 in.) termination wire to the closest earth ground.

Refer to Pigtail Terminations on page 62 for more information.

Pigtail Terminations

TL-Series motors have a short pigtail cable that connects to the motor, but is not shielded. The preferred method for grounding the TL-Series power cable on the motor side is to expose a section of the cable shield and clamp it directly to the machine frame. The motor power cable also has a 150 mm (6.0 in.) shield termination wire with a ring lug that connects to the closest earth ground. Use this method in addition to the cable clamp. The termination wire may be extended to the full length of the motor pigtail if necessary, but it is best to connect the supplied wire directly to ground without lengthening.

Figure 34 - Pigtail Terminations



(1) Remove paint from machine frame to be sure of proper HF-bond between machine frame, motor case, shield clamp, and ground stud.

Table 23 - Motor Power Cable Compatibility

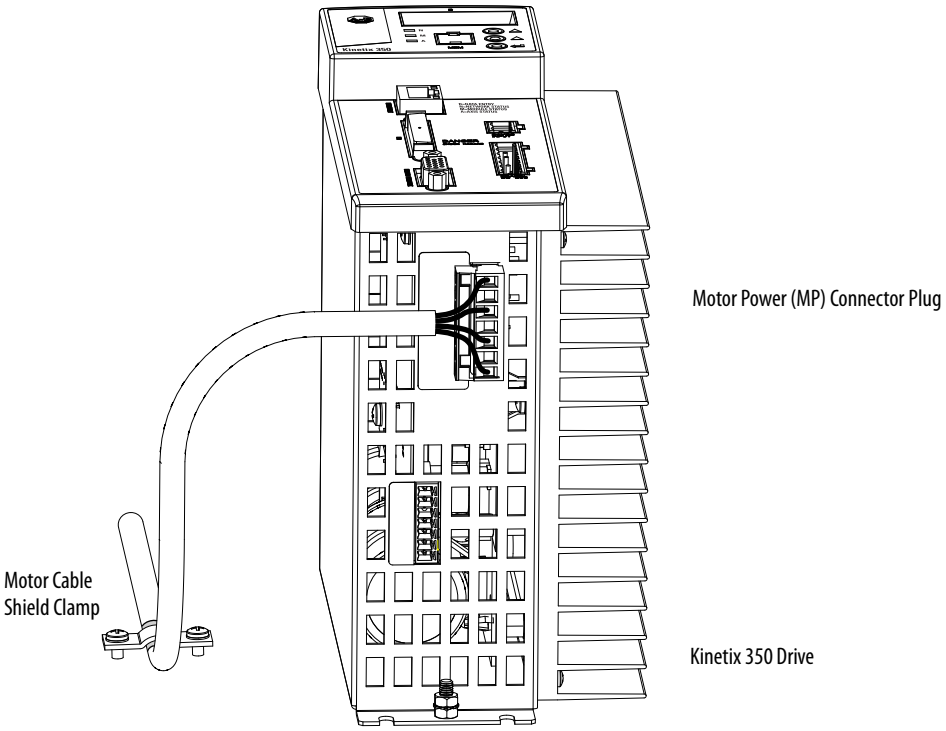
Motor/Actuator	Connector	Motor/Actuator Cat. No.	Motor Power Cables (with brake wires)	Motor Power Cables (without brake wires)
MP-Series (Bulletin MPL)	Circular DIN	MPL-A/B15*xxx*-4*x*AA and MPL-A/B2*xxx*-4*x*AA	2090-XXNPMF-*xx*S*xx* (standard) 2090-CPBM4DF-*xx*AF*xx* (continuous-flex)	2090-CPWM4DF-*xx*AF*xx* (continuous-flex)
		MPL-A/B3*xxx*-7*x*AA, MPL-A/B4*xxx*-7*x*AA, and MPL-A/B45*xxx*-7*x*AA	2090-CPBM7DF-*xx*AA*xx* (1) (standard) 2090-CPBM7DF-*xx*AF*xx* (1) (continuous-flex)	2090-CPWM7DF-*xx*AA*xx* (1) (standard) 2090-CPWM7DF-*xx*AF*xx* (1) (continuous-flex)
MP-Series (Bulletin MPS)		MPS-A/B*xxxx*	2090-XXNPMF-*xx*S*xx* (standard) 2090-CPBM4DF-*xx*AF*xx* (continuous-flex)	2090-CPWM4DF-*xx*AF*xx* (continuous-flex)
MP-Series (Bulletin MPAS)		MPAS-A/B*xxxx*		
MP-Series (Bulletin MPAR)		MPAR-A/B1*xxx* and MPAR-A/B2*xxx*		
MP-Series (Bulletin MPM)		MPM-A/B*xxxx*	2090-CPBM7DF-*xx*AA*xx* (1) (standard) 2090-CPBM7DF-*xx*AF*xx* (1) (continuous-flex)	2090-CPWM7DF-*xx*AA*xx* (1) (standard) 2090-CPWM7DF-*xx*AF*xx* (1) (continuous-flex)
MP-Series (Bulletin MPF)		MPF-A/B*xxxx*		
MP-Series (Bulletin MPAR)		MPAR-A/B3*xxx*		
MP-Series (Bulletin MPAI)		MPAI-A/B*xxxx*		
TL-Series (Bulletin TLY)	Circular Plastic	TLY-A*xxxx*	2090-CPBM6DF-16AA*xx* (standard)	2090-CPWM6DF-16AA*xx* (standard)
TL-Series (Bulletin TLAR)		TLAR-A*xxxx*		

(1) You must remove the motor-side o-ring when using 2090-CP*x*M7DF-*xx*A*xx* cables.

This diagram shows an example of three-phase power wires for motors/actuators that have no brakes. Thermal switch wires are included in the feedback cable.

Refer to Kinetix 350 Drive/Rotary Motor Wiring Examples beginning on page 146 for interconnect diagrams.

Figure 35 - Motor Power Terminations (three-phase wires only)

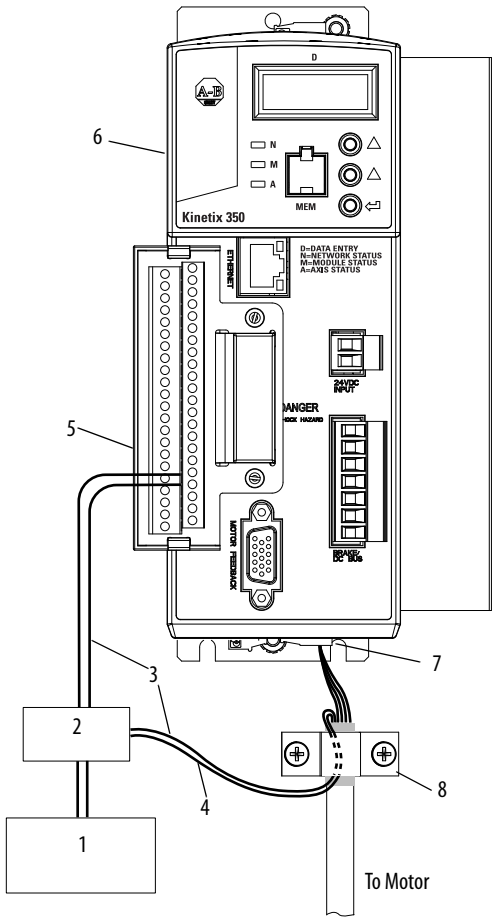


The cable shield clamp shown above is mounted to the subpanel. Ground and secure the motor power cable in your system following instructions on page 66.

This diagram shows an example of wiring with three-phase power wires and brake wires. The brake wires have a shield braid (shown below as gray) that folds back under the cable clamp before the conductors are attached to the motor brake circuit. Thermal switch wires are included in the feedback cable.

Refer to Kinetix 350 Drive/Rotary Motor Wiring Examples beginning on page 146 for interconnect diagrams.

Figure 36 - Motor Power Terminations (three-phase and brake wires)



Item	Description
1 (1)	24V power supply
2 (1)	Relay and diode assembly (3)
3	Minimize unshielded wires in brake circuit
4	MP-Series cable brake wires

Item	Description
5	I/O (IOD) connector(2)
6	2097-V3*x*PR*x*-LM Kinetix 350 drive
7	Motor power (MP) connector
8	Cable clamp (4)

(1) User supplied. Size as required by motor brake, See Motor Brake Currents on page 149.

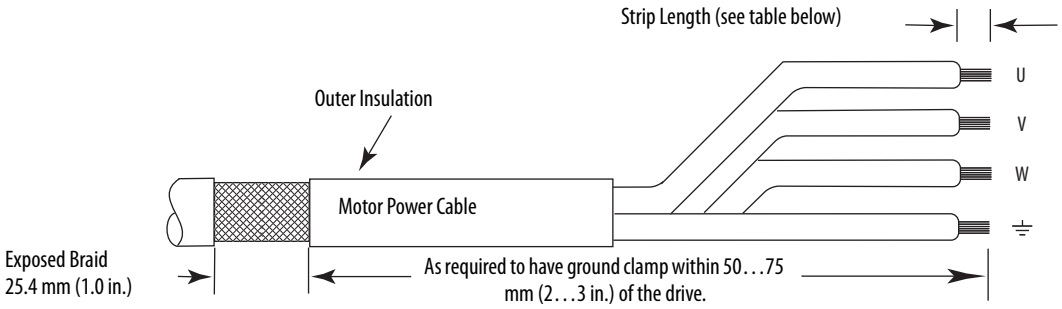
(2) Pin 43 and 44 are configured as MTR_ BRAKE+ and MTR_BRAKE- Common respectively. Wire the output as sourcing and set brake engage and disengage times for motor selected. Motor brake is active on enable.

(3) Diode 1N4004 rated 1.0 A @ 400V DC. See Interconnect Diagram Notes beginning on page 141.

(4) Exposed shield under clamp and place within 50…75 mm (2…3 in.) of drive, see page 66 for details.

Cable shield and lead preparation is provided with most Allen-Bradley cable assemblies. Follow these guidelines if your motor power cable shield and wires require preparation.

Figure 37 - Cable Shield and Lead Preparation



Refer to Shunt Resistor Wiring Example beginning on page 146 for interconnect diagrams.

Table 24 - Motor Power (MP) Connector

MP-Series or TL-Series Servo Motor	Terminal
U / Brown	U
V / Black	V
W / Blue	W
⏚ Green/Yellow	⏚

Table 25 - Motor Power (MP) Termination Specifications

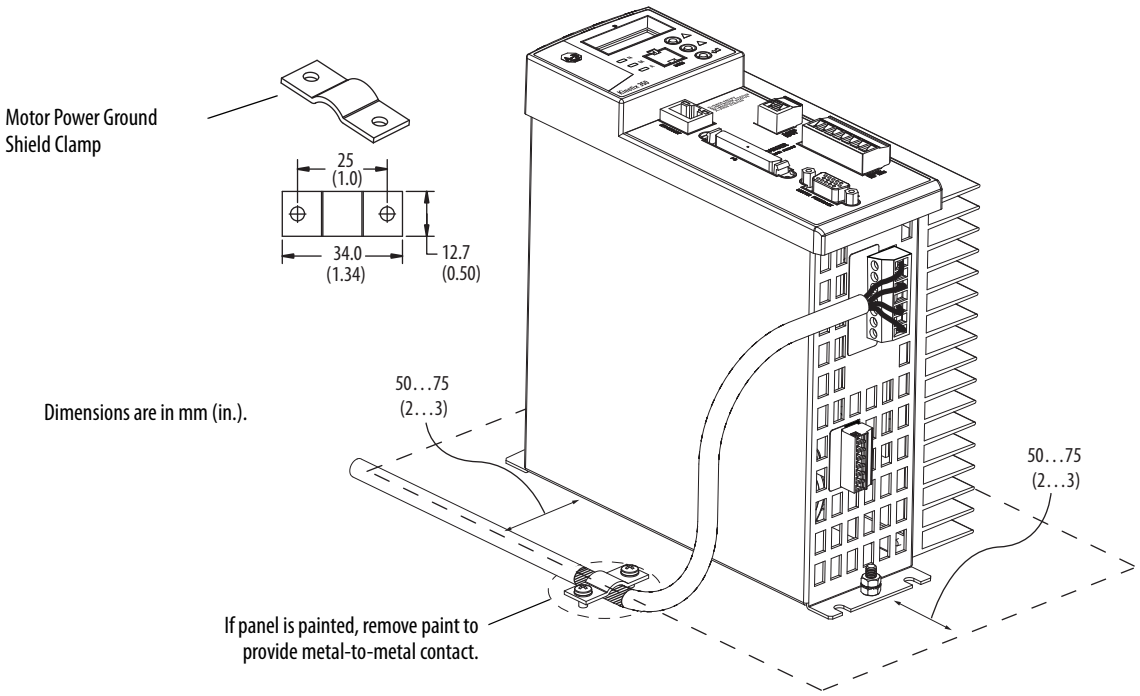
Drive Cat. No.	Terminals	Recommended Wire Size mm^2 (AWG)	Strip Length mm (in.)	Torque Value N•m (lb•in)
2097-V31PR0-LM 2097-V31PR2-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V32PR4-LM 2097-V33PR1-LM 2097-V33PR3-LM 2097-V33PR5-LM 2097-V34PR3-LM 2097-V34PR5-LM 2097-V34PR6-LM	PE W V U	2.5 (14)	7 (0.28)	0.5 (4.5)
2097-V33PR6-LM		4.0 (12)		

Apply the Motor Cable Shield Clamp

This procedure assumes you have completed wiring your motor power (MP) connector and are ready to apply the cable shield clamp.

Follow these steps to apply the motor cable shield clamp.

1. Locate a suitable position for installing cable shield clamp within 50...75 mm (2...3 in.) of the drive.



2. Lay out and drill holes for cable clamp.

ATTENTION: Plan the installation of your system so that you can perform all cutting, drilling, tapping, and welding with the system removed from the enclosure. Because the system is of the open type construction, be careful to keep any metal debris from falling into it. Metal debris or other foreign matter can become lodged in the circuitry, which can result in damage to components.

3. Locate the position on the motor power cable that comes under the clamp and remove about an inch of the cable jacket to expose the shield braid.
4. Position the exposed portion of the cable braid directly in line with the clamp.
5. Clamp the exposed shield to the panel by using the clamp and two #6-32 x 1 screws provided.
6. Repeat step 1...step 5 for each Kinetix 350 drive you are installing.

Feedback and I/O Cable Connections

Factory made cables with premolded connectors are designed to minimize EMI and are recommended over hand-built cables to improve system performance. However, other options are available for building your own feedback and I/O cables.

Table 26 - Options for Connecting Motor Feedback and I/O

Connection Option	Cat. No.	Cable	Using This Type of Cable
Premolded connectors	N/A	Motor feedback	Refer to the table below for the premolded motor feedback cable available for your motor.
Low-profile connector	2090-K2CK-D15M	Motor feedback	Refer to the table below for the flying-lead cable available for your motor.
I/O Terminal Block	2097-TB1	I/O interface	User-supplied flying-lead cable.

Table 27 - Motor Feedback Cables for Specific Motor/Feedback Combinations

Motor Cat. No.	Feedback Type	Feedback Cable	
		Premolded	Flying-lead
MPL-A/B15*xxx*-V/E*x*4*x*AA, MPL-A/B2*xxx*-V/E*x*4*x*AA	High-resolution encoder	N/A	2090-XXNFMF-S*xx* (standard) 2090-CFBM4DF-CDAF*xx* (continuous-flex)
MPL-A/B15*xxx*-H*x*4*x*AA, MPL-A/B2*xxx*-H*x*4*x*AA	Incremental encoder		
MPL-A/B3*xxx*-H*x*7*x*AA, MPL-A/B4*xxx*-H*x*7*x*AA, MPL-A/B45*xxx*-H*x*7*x*AA		N/A	2090-XXNFMF-S*xx* (standard) 2090-CFBM7DF-CDAF*xx* (1) (continuous-flex)
MPL-A/B3*xxx*-M/S*x*7*x*AA, MPL-A/B4*xxx*-M/S*x*7*x*AA, MPL-A/B45*xxx*-M/S*x*7*x*AA	High-resolution encoder	2090-CFBM7DD-CEAA*xx* (1) (standard) 2090-CFBM7DD-CEAF*xx* (1) (continuous-flex)	2090-CFBM7DF-CEAA*xx* (1) (standard) 2090-CFBM7DF-CEAF*xx* (1) (continuous-flex)
MPM-A/B*xxxxx*-M/S	High-resolution encoder		
MPF-A/B*xxxx*-M/S			
MPAR-A/B3*xxxx*			
MPAI-A/B*xxxx*			
MPS-A/B*xxxx*-M/S		N/A	2090-XXNFMF-S*xx* (standard) 2090-CFBM4DF-CDAF*xx* (continuous-flex)
MPAS-A/B*xxxx*-V/A			
MPAR-A/B1*xxxx*, MPAR-A/B2*xxxx*			
TLY-A*xxxx*-B	High-resolution encoder	2090-CFBM6DD-CCAA*xx* (standard)	2090-CFBM6DF-CBAA*xx* (standard)
TLAR-A*xxxxx*			
TLY-A*xxxx*-H	Incremental encoder		

(1) You must remove the motor-side o-ring when using 2090-CP*x*M7DF-*xx*A*xx* cables.

Flying-lead Feedback Cable Pin-outs

Table 28 - 2090-XXNFMF-S*xx* or 2090-CFBM*x*DF-*xx*A*xxx* Feedback Cable

Connector Pin	High-resolution Feedback		Incremental Feedback	Drive MF Connector Pin
	9V Encoder	5V Encoder	5V Encoder	
1	Sin+	Sin+	AM+	1
2	Sin-	Sin-	AM-	2
3	Cos+	Cos+	BM+	3
4	Cos-	Cos-	BM-	4
5	Data+	Data+	IM+	5
6	Data-	Data-	IM-	10
9	Reserved	EPWR_5V	EPWR_5V	14
10	Reserved	ECOM	ECOM	6
11	EPWR_9V	Reserved	Reserved	7
12	ECOM	Reserved	Reserved	6
13	TS+	TS+	TS+	11
14	TS-	TS-	TS-	–
15	Reserved	Reserved	S1	12
16	Reserved	Reserved	S2	13
17	Reserved	Reserved	S3	8

Table 29 - 2090-CFBM6DF-CBAA*xx* Feedback Cable

Connector Pin	High Resolution	Incremental Feedback	Drive MF Connector Pin
	TLY-A*xxxx*-B TLAR-A*xxxxx*	TLY-A*xxxx*-H	
6	BAT+	Reserved	BAT+
9	Reserved	AM+	1
10		AM-	2
11		BM+	3
12		BM-	4
13	DATA+	IM+	5
14	DATA-	IM-	10
15	Reserved	S1	12
17		S2	13
19		S3	8
22	EPWR 5V	EPWR 5V	14
23	ECOM and BAT-	ECOM	6
24	Shield	Shield	Connector housing

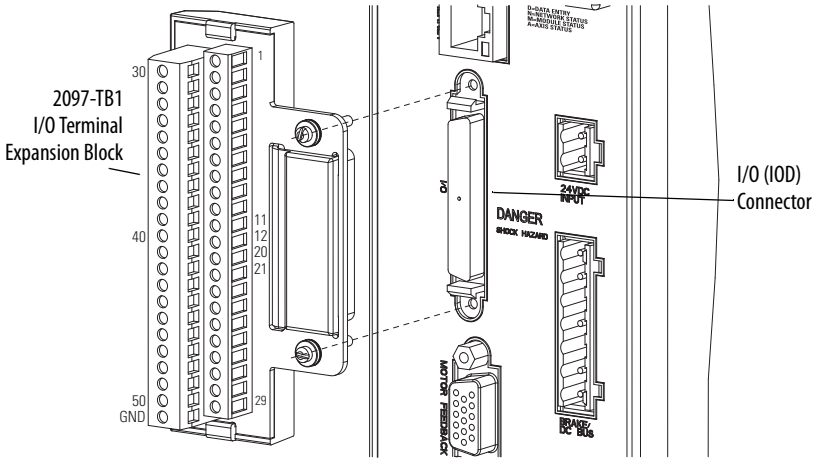
Wiring the Feedback and I/O Connectors

These procedures assume you have mounted your Kinetix 350 system, completed the power wiring, and are ready to connect motor feedback.

Wire the I/O Connector

Connect your I/O wires to the IOD connector by using the 2097-TB1 I/O Terminal Expansion Block. Refer to the Kinetix 300 I/O Terminal Expansion Block Installation Instructions, publication 2097-IN005.

Figure 38 - Kinetix 350 Drive (IOD connector and terminal block)



Wire the Low-profile Connector Kit

The 2090-K2CK-D15M low-profile connector kit is suitable for terminating flying-lead motor feedback cables. Use it with the Kinetix 350 drive and all motors with incremental or high-resolution feedback. It has a 15-pin, male, D-sub connector and is compatible with all Bulletin 2090 feedback cables.

TLY-A*xxxx*-B rotary motors and TLAR-A*xxxxx* electric cylinders also require the 2090-DA-BAT2 battery to back up the high-resolution encoder.

Figure 39 - Kinetix 350 Drive (MF connector)

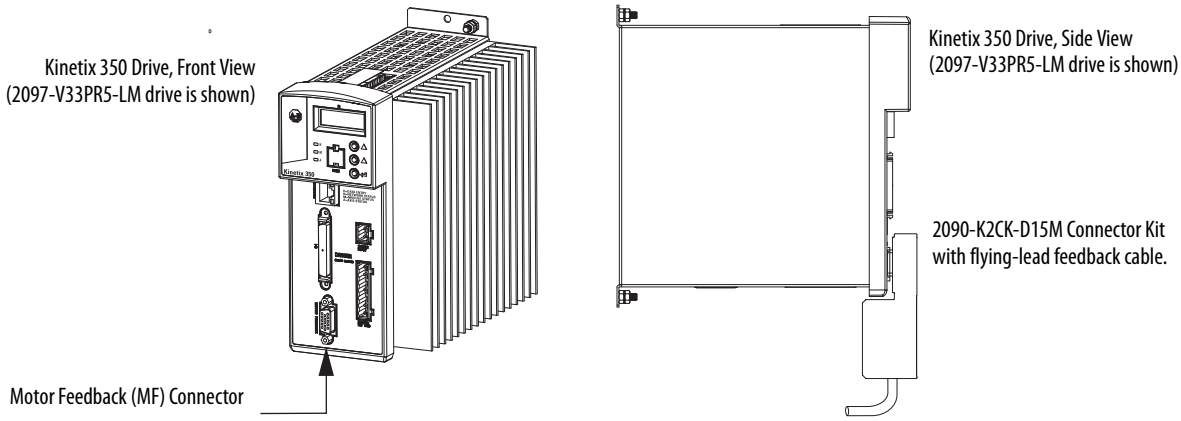
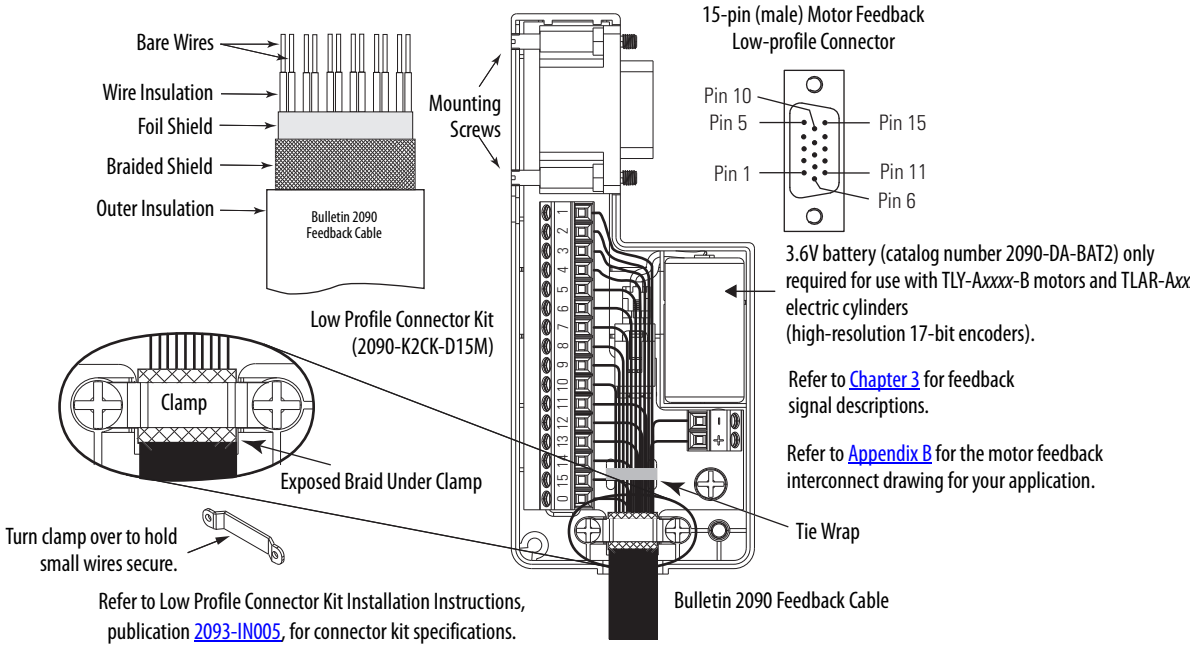


Figure 40 - Wiring (15-pin) Flying-lead Feedback Cable Connections 2090-K2CK-D15M Connector Kit



Shunt Resistor Connections

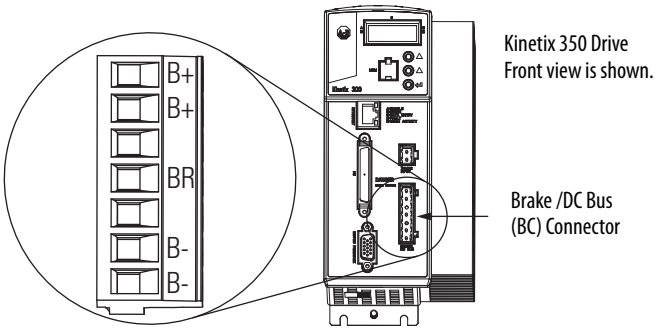
Follow these guidelines when wiring your 2097-R*x* shunt resistor.

IMPORTANT When tightening screws to secure the wires, refer to the tables beginning on page 55 for torque values.

IMPORTANT To improve system performance, run wires and cables in the wireways as established in Chapter 2.

- Refer to Shunt Resistors on page 26 for noise zone considerations.
- Refer to Shunt Resistor Wiring Example on page 145.
- Refer to the installation instructions provided with your Bulletin 2097 shunt resistor, publication 2097-IN002.

Figure 41 - Brake/DC Bus (BC) Connector



Ethernet Cable Connections

This guideline assumes you have your Logix Ethernet/IP module and Kinetix 350 drive mounted and ready to connect the network cables.

IMPORTANT Connection to a larger network through an un-managed switch without Internet Group Management Protocol Snooping could cause degradation to the larger network. Network switches without IEEE-1588 will impact the overall system accuracy. However, for general time stamping this switch type is usually sufficient. Your overall network topology, number of connected nodes and choice of EtherNet switch affects motion performance. For more detailed information on designing your network, please consult the Converged Plantwide Ethernet Design & Implementation Guide, publication ENET-TD001.

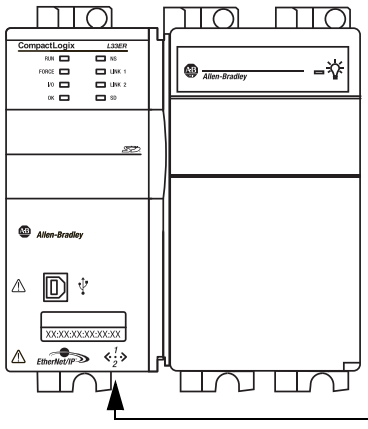
The EtherNet/IP network is connected by using the Port 1 connector. Refer to page 30 to locate the Ethernet connector on your Kinetix 350 drive. Refer to the figure below to locate the connector on your Logix communication module.

Shielded Ethernet cable is available in lengths up to 78 m (256 ft). However, the total length of Ethernet cable connecting drive-to-drive, drive-to-controller, or drive-to-switch must not exceed 100 m (328 ft).

If the entire channel is constructed of stranded cable (no fixed cable), then this is the equation for calculating maximum length:

Maximum Length = (113-2N)/y, meters
where N = the number of connections in the channel
and y = the loss factor compared to fixed cable (typically 1.2...1.5).

Figure 42 - CompactLogix Ethernet Port Location

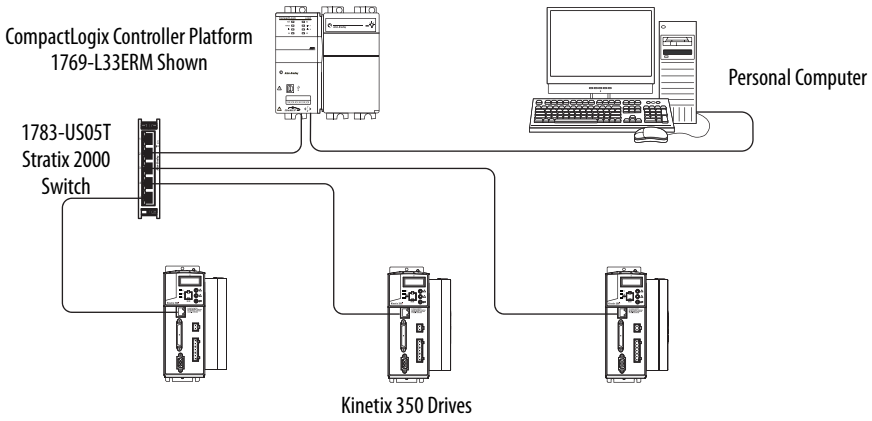


CompactLogix Controller Platform
1769-L33ERM Shown

The Ethernet ports are on bottom of controller.

The Port 1 Ethernet connection is used for connecting to a Logix controller and configuring your Kinetix 350 drive.

Figure 43 - Ethernet Wiring Example - External Switch



Notes:

Configure and Start Up the Kinetix 350 Drive System

Introduction

This chapter provides procedures for configuring your Kinetix 350 system components with your ControlLogix® EtherNet/IP controller.

TIP Before you begin make sure you know the catalog number for the drive, the Logix controller, and the servo motor/actuator in your motion control application.

Keypad Input

The Kinetix 350 drive is equipped with a diagnostic status indicator and three push buttons that are used to select displayed information and to edit a limited set of parameter values. Parameters can be scrolled by using ▲▼. To view a value, press ↵. To return back to Scroll mode press ↵.

After pressing ↵ on editable parameters, the yellow status indicator D blinks indicating that the parameter value can be changed. Use ▲▼ to change the value. Press ↵ to store the new setting and return back to Scroll mode.

Table 30 - Status Display Information

Status Indicator	Description
Hx.xx	Hardware revision. For example, H2.00.
Fx.xx	Firmware revision. For example, F2.06.
dHCP	Ethernet DHCP Configuration: 0='dHCP' is disabled; 1='dHCP' is enabled.
IP_1	Allows modification of the first octet of the IP address.
IP_2	Allows modification of the second octet of the IP address.
IP_3	Allows modification of the third octet of the IP address.
IP_4	Allows modification of the fourth octet of the IP address.
nEt1	Allows modification of the first octet of the netmask.
nEt2	Allows modification of the second octet of the netmask.
nEt3	Allows modification of the third octet of the netmask.
nEt4	Allows modification of the fourth octet of the netmask.
gat1	Allows modification of the first octet of the gateway.
gat2	Allows modification of the second octet of the gateway.
gat3	Allows modification of the third octet of the gateway.
gat4	Allows modification of the fourth octet of the gateway.

Status Indicators

The Kinetix 350 drive has four status indicators and a four-digit display on the top front panel as shown below. These status indicators and the display are used to monitor the system status, activity, and troubleshoot faults.

Figure 44 - Front Panel Display

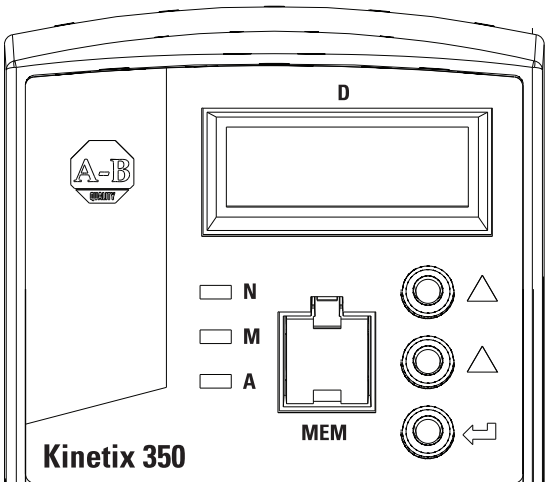


Table 31 - Status Indicators

Status Indicator	Function	Description
D	Data entry	Yellow status indicator will flash when changing.
N	Network state	Indicates the state of the Network. See Network State Status Indicator on page 78. The bicolored status indicator shows red, green, or amber.
M	Module state	Indicates the state of the Network. See Module State Status Indicator on page 77. The bicolored status indicator shows red, green, or amber.
A	Axis state	Indicates the state of the Network. See Axis State Status Indicator on page 78. The bicolored status indicator shows red, green, or amber.

Table 32 - Module State Status Indicator

Status Indicator	State
Off	Power off
Flash red/green	Drive self-testing
Flashing green	Standby
Solid green	Operational
Flashing red	Major recoverable fault
Solid red	Major unrecoverable fault

Table 33 - Axis State Status Indicator

Status Indicator	State
Off	Off
Flash red/green	Self test
Off	Initialization - bus not up
Flashing green	Initialization - bus up
Off	Shutdown - bus not up
Flashing amber (1)	Shutdown - bus up
Off	Pre-charge - bus not up
Flashing amber (1)	Start inhibit
Flashing green (1) (2)	Stopped
Solid green (1) (2)	Stopping
	Starting
	Running
	Testing
Flashing red	Aborting
	Major faulted
Solid red	Aborting
	Major faulted

(1) The axis and the drive define minor fault conditions. While a minor fault does not affect the drive status indicator, it does affect the axis status indicator. When a minor fault condition is detected, a normally solid green status indicator indication changes to alternating red-green-red-green, a normally flashing green status indicator indication changes to alternating red-off-green-off, and a normally flashing amber indications changes to red-off-amber-off.

(2) The drive also defines alarm conditions. When an alarm condition is detected, a normally solid green status indicator indication changes to alternating amber-green-amber green while a normally flashing green status indicator indication changes to alternating amber-off-green-off.

Table 34 - Network State Status Indicator

Status Indicator	State
Steady off	Not powered, no IP address
Flashing green	No connections
Steady green	Connected
Flashing red	Connection time-out
Steady red	Duplicate IP
Flashing green and red	Self-test

Configure the Kinetix 350 Drive Ethernet IP Address

This section offers guidance on configuring your Ethernet connection to the Kinetix 350 drive.

Ethernet Connection

Configuration, programming, and diagnostics of the Kinetix 350 drive are performed over the standard 10/100 Mbps Ethernet communication port by using the RSLogix™ 5000 software.

The Kinetix 350 drive and your personal computer must be configured to operate on the same Ethernet network. The IP addresses of the Kinetix 350 drive, the personal computer, or both drive and personal computer may require configuring to enable Ethernet communication between the two devices.

IMPORTANT Any changes made to the Ethernet communication settings on the Kinetix 350 drive do not take effect until the drive is powered off and powered on again. Until the power is cycled the drive continues to use its previous settings.

Kinetix 350 Drive Ethernet Port Configuration

The IP address of the Kinetix 350 drive is composed of four sub-octets that are separated by three dots to conform to the Class C Subnet structure. Each sub-octet can be configured with number between 1 and 254. As shipped from the factory the default IP address of a drive is 192.168.124.200.

There are two methods of changing the current IP address. An address can be assigned to the drive automatically (dynamic IP address) when the drive is connected to a DHCP (Dynamic Host Configuration Protocol) enabled server, or you can manually assign an IP address to the drive (static IP address). Both methods of configuring the drive's IP address are shown here.

Obtain the Kinetix 350 Drives' Current Ethernet Settings

The current Ethernet setting and IP address of the Kinetix 350 drive can be obtained from the drive display and keypad. Press  on the display and use  to access parameters IP_1, IP_2, IP_3, and IP_4. Each of these parameters contain one sub-octet of the full IP address, for example in the case of the drive default (factory set) address parameters:

IP_1 = 192
IP_2 = 168
IP_3 = 124
IP_4 = 200

By accessing these four parameters the full IP address on the drive can be obtained.

If parameters IP_1, IP_2, IP_3, and IP_4 all contain '----' rather than a numerical values it means that the drive has DHCP enabled and the DHCP server is yet to assign the drive its dynamic IP address. As soon as an IP address is assigned by the server the address assigned is displayed by the drive in the above parameters. See Configure the IP Address Automatically (dynamic address) on page 81.

Configure the IP Address Manually (static address)

When connecting directly from the Kinetix 350 drive to the personal computer without a server or when connecting to a private network, where all devices have static IP addresses, assign the IP address of the Kinetix 350 drive manually.

To assign the address manually, disable the DHCP mode. Do this by using the drive keypad and following these steps.

1. Press .
2. Use to access parameter DHCP.
3. Check this parameter is set to a value of 0.
4. If the DHCP parameter is set to 1 then use and to set to 0.
5. Cycle power to the drive.

   The change takes effect.

When DHCP is disabled and power cycled to the drive, it reverts back to its previous static IP address.

If you are connecting more than one drive to the personal computer create unique IP address for each drive. Do this by using the keypad on each drive to change the IP_4 parameter. IP_4 is the only octet that can be changed via the keypad. IP_1, IP2, and IP_3 are read-only accessed this way. The dive power must be cycled for any changes to take effect.

Configure the IP Address Automatically (dynamic address)

When connecting a Kinetix 350 drive to a network domain with a DHCP enabled server the IP address of the Kinetix 350 drive is assigned automatically. To have the address assigned automatically the drive must have its DHCP mode enabled. Follow these steps using the drive keypad and display.

1. Press .
2. Use the to access parameter DHCP.
3. Check this parameter is set to 1.
4. If the DHCP parameter is set to 0, use and to set the parameter to 1.
5. Cycle power to the drive to make this change take effect.

When the Kinetix 350 drive is waiting for an IP address to be assigned to it by the server it displays '----' in each of the four octet parameters (IP_1, IP_2, IP_3, and IP_4) on its display. Once the address is assigned by the server it appears in these parameters. If this parameter continues to display '----' then it is likely that a connection between the drive and server has not been established, or the server is not DHCP enabled.

DHCP can be enabled through the RSLogix 5000 software. If you choose to configure the drive by using a manual (static) IP address, you can switch over to an automatic (dynamic) address once configuration is complete. See Obtain the Kinetix 350 Drives' Current Ethernet Settings on page 79 for information on enabling DHCP from within the RSLogix 5000 software.

TIP A useful feature of the RSLogix 5000 software and communication interface to the Kinetix 350 drive is the ability to assign the drive a name (text string). This name can then be used to discover the drive's IP address and is useful when the drive has its IP address assigned automatically by the server for easy connection.

Configure the Logix EtherNet/IP Controller

This procedure assumes that you have wired your Kinetix 350 drive system and are using RSLogix 5000 software version 20.*xx* or later.

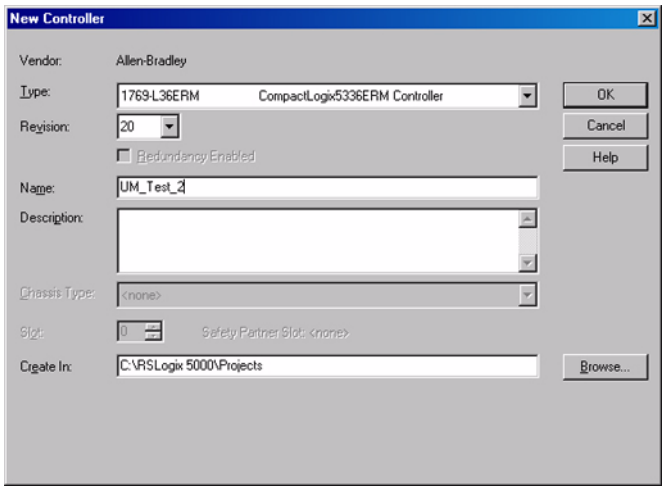
For help using RSLogix 5000 software as it applies to configuring the ControlLogix EtherNet/IP controller, refer to Additional Resources on page 8.

Configure the Logix Controller

Follow these steps to configure the Logix controller.

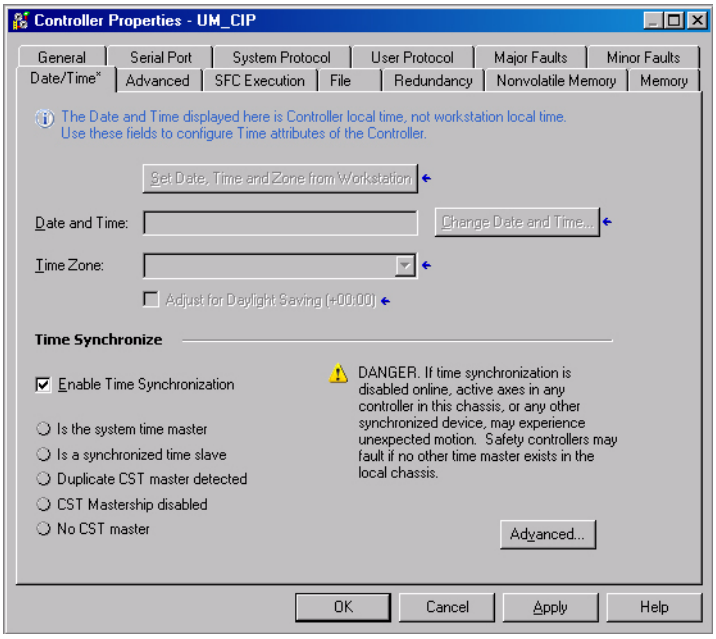
1. Apply power to your Logix controller containing the EtherNet/IP port and open your RSLogix 5000 software.
2. From the File menu, choose New.

   The New Controller dialog box opens.



3. Configure the new controller.
   a. From the Type pull-down menu, choose the controller type.
   b. From the Revision pull-down menu, choose the revision.
   c. Type the file Name.
4. Click OK.
5. From the Edit menu, choose Controller Properties.

The Controller Properties dialog box opens.



6. Click the Date/Time tab.
7. Check Enable Time Synchronization.

   This will permit the controller to participate in the ControlLogix Time Synchronization or CIP Sync. The controller will also participate in an election in the Logix system for the best GrandMaster clock.
8. Click OK.

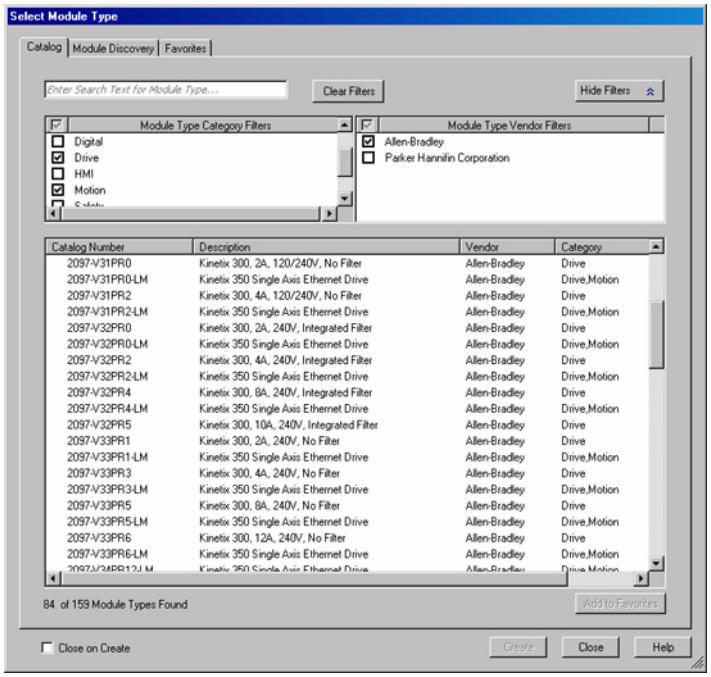
Configure the Kinetix 350 Drive

IMPORTANT To configure Kinetix 350 drive (catalog numbers 2097-V3xPRx-LM) you must be using RSLogix 5000 software, version 20 or later.

Follow these steps to configure the Kinetix 350 drive.

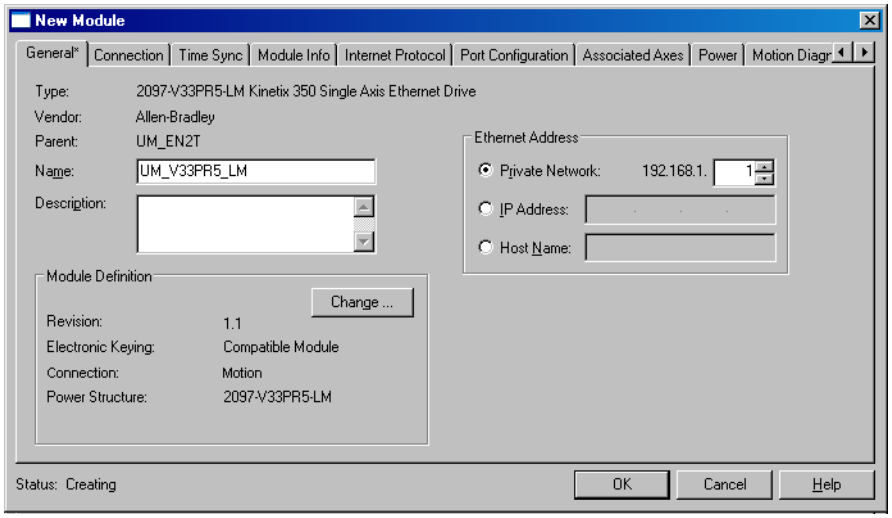
1. Right-click the Logix EtherNet/IP controller you just created and choose New Module.

   The Select Module dialog box opens.



2. Clear the Module Type Category Filter and check the Drive and Motion catagories.
3. Select your 2097-V3*x*PR*x*-LM drive as appropriate for your actual hardware configuration and click Create.

The New Module dialog box opens.

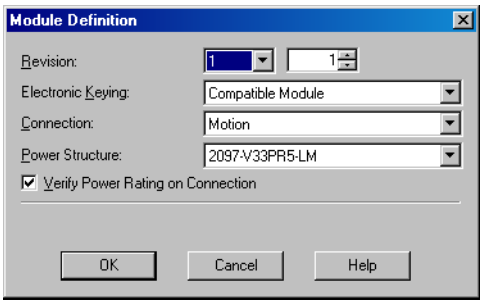


4. Configure the new drive.
   a. Type the drive Name.
   b. Click an Ethernet Address option.

      In this example, the Private Network address is selected.
   c. Enter the address of your EtherNet/IP drive.

      In this example, the last octet of the address is 1. This must match the base node address of the drive.
5. Click Change in the Module Definition area.

   The Module Definition dialog box opens.



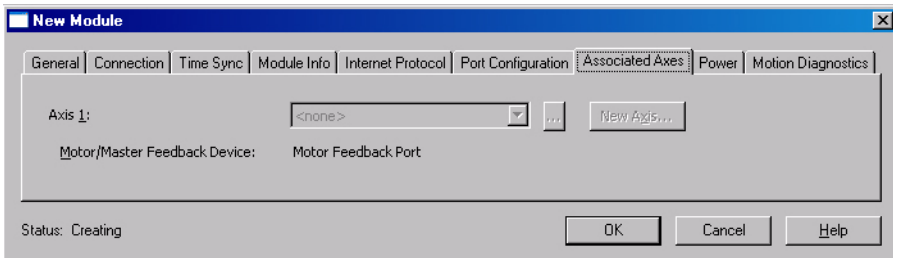
6. From the Power Structure pull-down menu, choose the Bulletin 2097 drive appropriate for your application.

   In the example, the 2097-V3xPRx-LM module is chosen.
7. Click OK to close the Module Definition dialog box.
8. Click OK to close the Module Properties dialog box.

   The 2097-V3xPRx-LM drive appears under the EtherNet/IP module in the I/O Configuration folder.
9. Right-click the 2097-V3xPRx-LM module you just created and choose Properties.

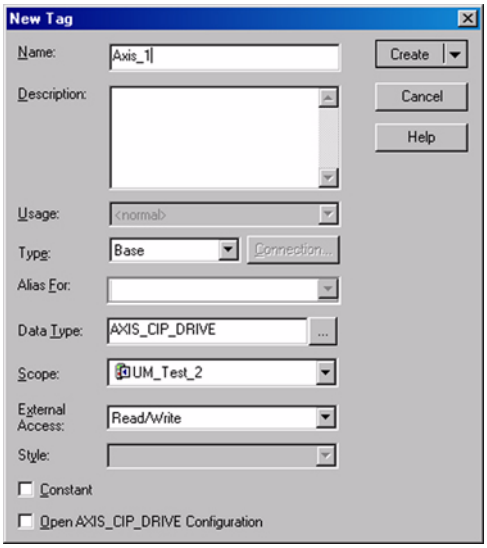
   The Module Properties dialog box opens.

10. Click the Associated Axes tab.



11. Click New Axis.

    The New Tag dialog box opens.

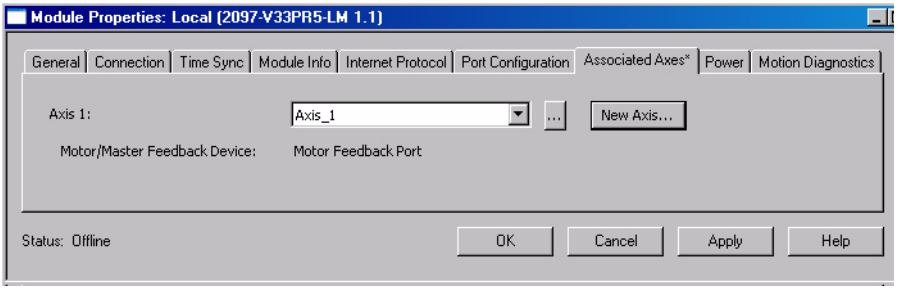


12. Type the axis Name.

    AXIS_CIP_DRIVE is the default Data Type.

13. Click Create.

    The new axis (Axis_1) appears under Motion Groups>Ungrouped Axes in the Controller Organizer and is assigned as Axis 1.



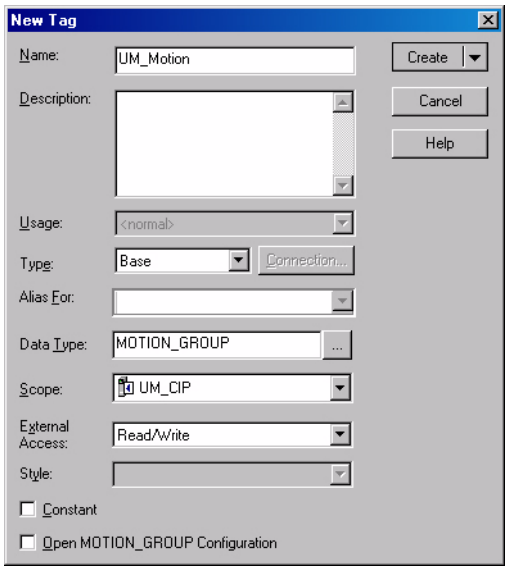
14. Click Apply.

Configure the Motion Group

Follow these steps to configure the motion group.

1. Right-click Motion Groups in the Controller Organizer and choose New Motion Group.

   The New Tag dialog box opens.

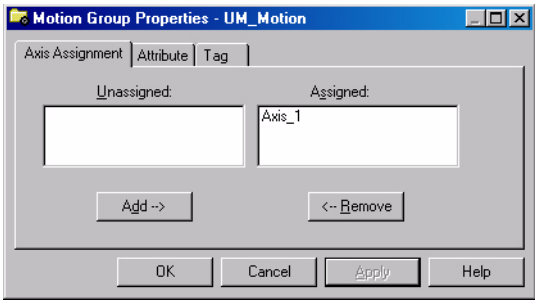


2. Type the new motion group Name.
3. Click Create.

   The new motion group appears under the Motion Groups folder.

4. Right-click the new motion group and choose Properties.

   The Motion Group Properties dialog box opens.



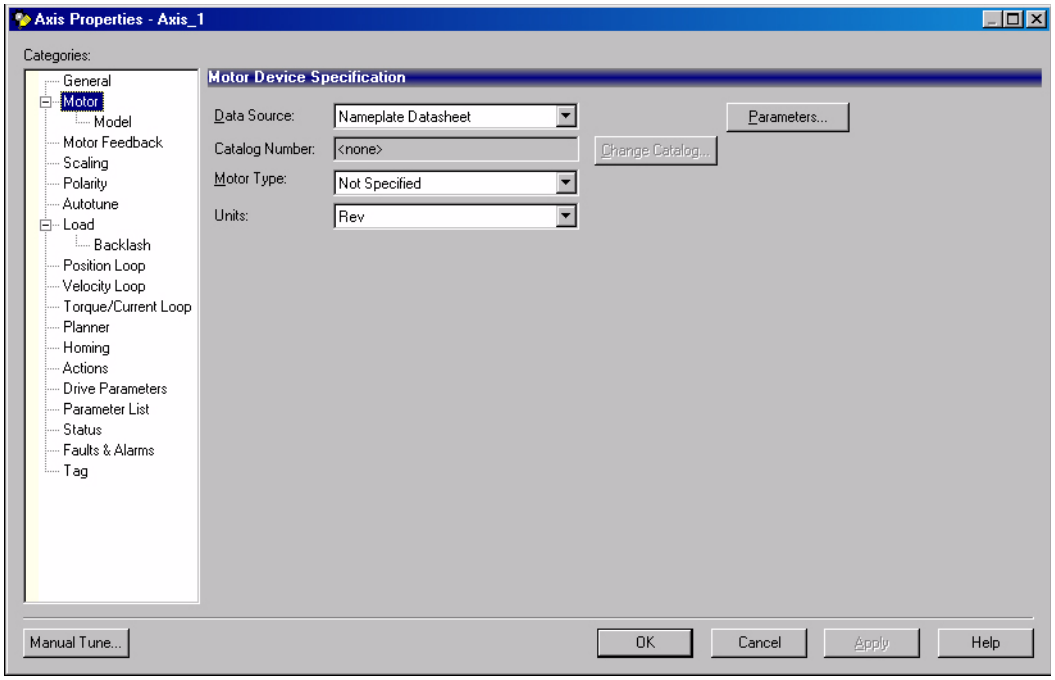
5. Click the Axis Assignment tab and move your axes (created earlier) from Unassigned to Assigned.
6. Click the Attribute tab and edit the default values as appropriate for your application.
7. Click OK.

Configure Axis Properties

Follow these steps to configure axis properties.

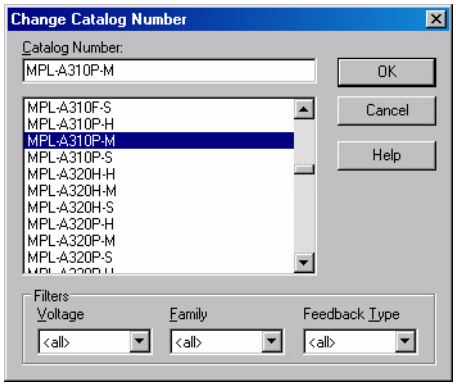
1. Right-click an axis in the Controller Organizer and choose Properties.
2. Click the Motor category.

   The Motor Device Specification dialog box opens.



3. From the Data Source pull-down menu, choose Catalog Number.
4. Click Change Catalog.

   The Change Catalog Number dialog box opens.



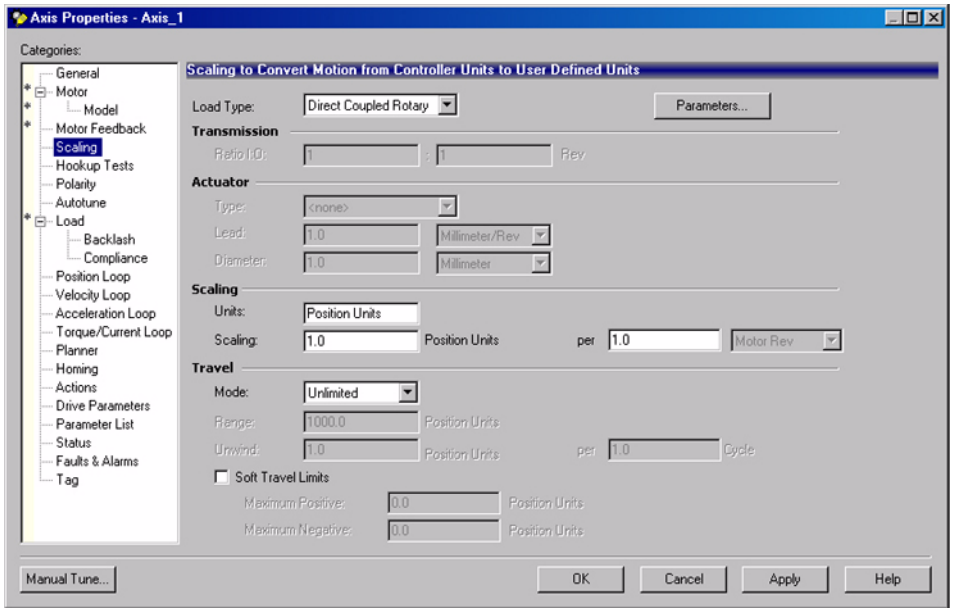
5. Select the motor catalog number appropriate for your application.

   To verify the motor catalog number, refer to the motor name plate.
6. Click OK to close the Change Catalog Number dialog box.

7. Click Apply.

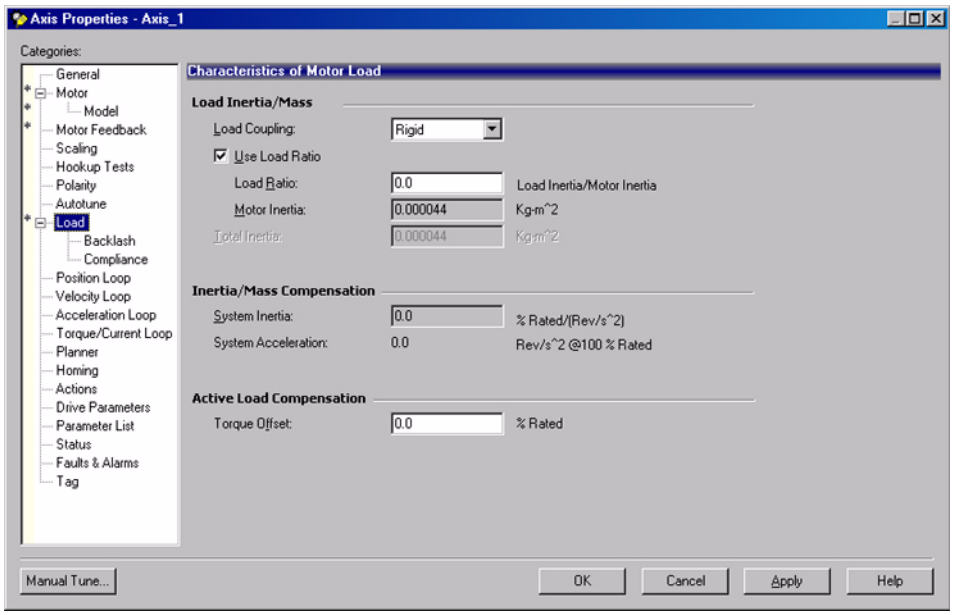
   Motor data specific to your motor appears in the Motor category.

8. Click the Scaling category and edit the default values as appropriate for your application.



9. Click Apply, if you make changes.

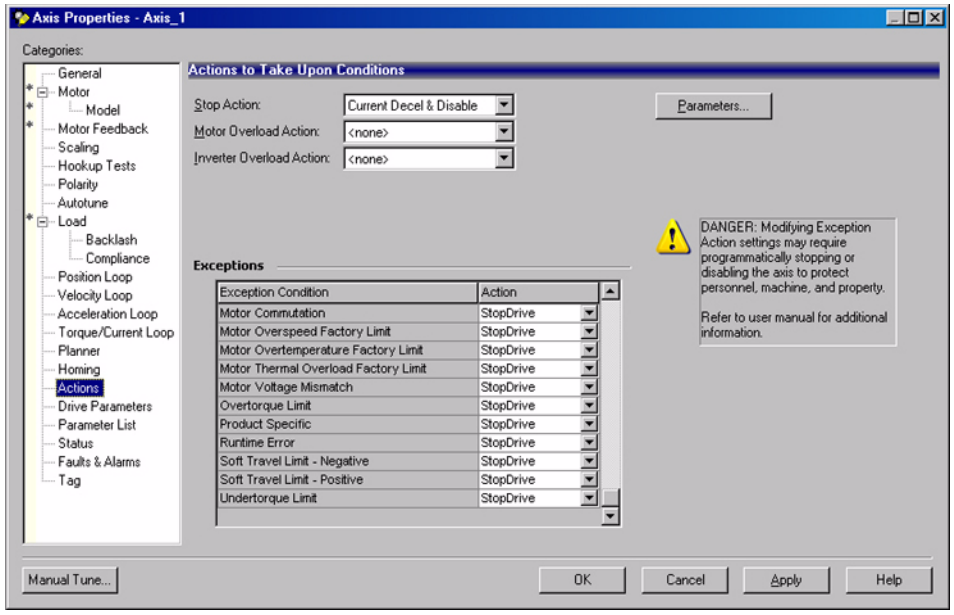
10. Click the Load category and edit the default values as appropriate for your application.



11. Click Apply, if you make changes.

12. Click the Actions category.

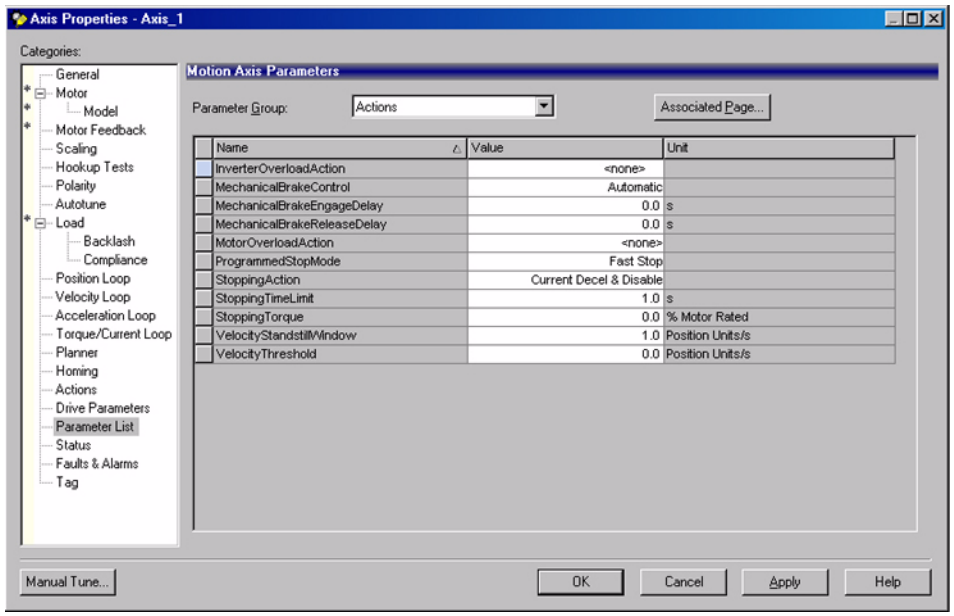
    The Actions to Take Upon Conditions dialog box opens.



    From this dialog box, you can program actions and change the action for exceptions (faults). Refer to Logix Controller and Drive Behavior on page 205 for more information.

13. Click Parameters.

    The Motion Axis Parameters dialog box opens.



    From this dialog box you can set delay times for servo motors. For recommended motor brake delay times, refer to the Kinetix Motion Control Selection Guide, publication GMC-SG001.

14. Click OK.

15. Verify your Logix program and save the file.

Download the Program

After completing the Logix configuration you must download your program to the Logix processor.

Apply Power to the Kinetix 350 Drive

This procedure assumes that you have wired and configured your Kinetix 350 drive system and your Ethernet/IP interface controller.

SHOCK HAZARD: To avoid hazard of electrical shock, perform all mounting and wiring of the Bulletin 2097 drive prior to applying power. Once power is applied, connector terminals may have voltage present even when not in use.

Follow these steps to apply power to the Kinetix 350 drive system.

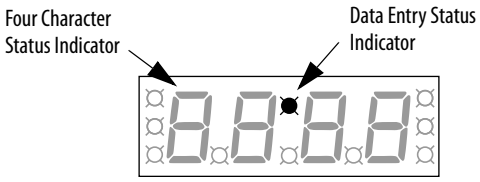
1. Disconnect the load to the motor.

ATTENTION: To avoid personal injury or damage to equipment, disconnect the load to the motor. Make sure each motor is free of all linkages when initially applying power to the system.

2. Determine the source of the drive logic power.

If Your Logic Power	Then
Is from (24V DC) back-up power	Apply (24V DC) back-up power to the drive (BP connector).
Mains input power	Apply 120, 240,or 460V AC mains input power to the drive (IPD connector).

3. Apply 120, 240, or 460V AC mains input power to the Kinetix 350 drive IPD connector.
4. Observe the four digit status indicator.



If the status indicator is	Then
-00-	Go to step 5
Blank	Go back to main step 2

5.

If Your Logic Power	Then
Is from (24V DC) back-up power	Apply 120, 240, or 460V AC mains input power to the drive (IPD connector)
Mains input power	Go to step 5

6.

If drive ENABLE is	Then
Hard wired	Apply 24V DC
Not used	Disable enableInputChecking using procedure on page 98

7. Observe the status indicator on the front of the Kinetix 350 drive.

Status Indicator	Condition	Status	Do This
Module	Steady green	Operational condition	Observe the Axis, status indicator page 77
	Steady or flashing red	Drive is faulted	Go to Module State Status Indicator on page 77
Axis	Steady green or amber, flashing	Operational condition	Observe the Network, status indicator page 77
	Steady or flashing red	Axis is faulted	Go to Axis State Status Indicator on page 78
Network	Steady green	Communication is ready	Go to Test and Tune the Axes on page 92
	Any state other than steady green	Communication error	Go to Network State Status Indicator on page 78

Test and Tune the Axes

This procedure assumes that you have configured your Kinetix 350 drive, your ControlLogix EtherNet/IP controller, and applied power to the system.

IMPORTANT Before proceeding with testing and tuning your axes, verify that the drive status indicators are operating as described in Status Indicators on page 117.

For help using RSLogix 5000 software as it applies to testing and tuning your axes with ControlLogix EtherNet/IP controller, refer to Additional Resources on page 8.

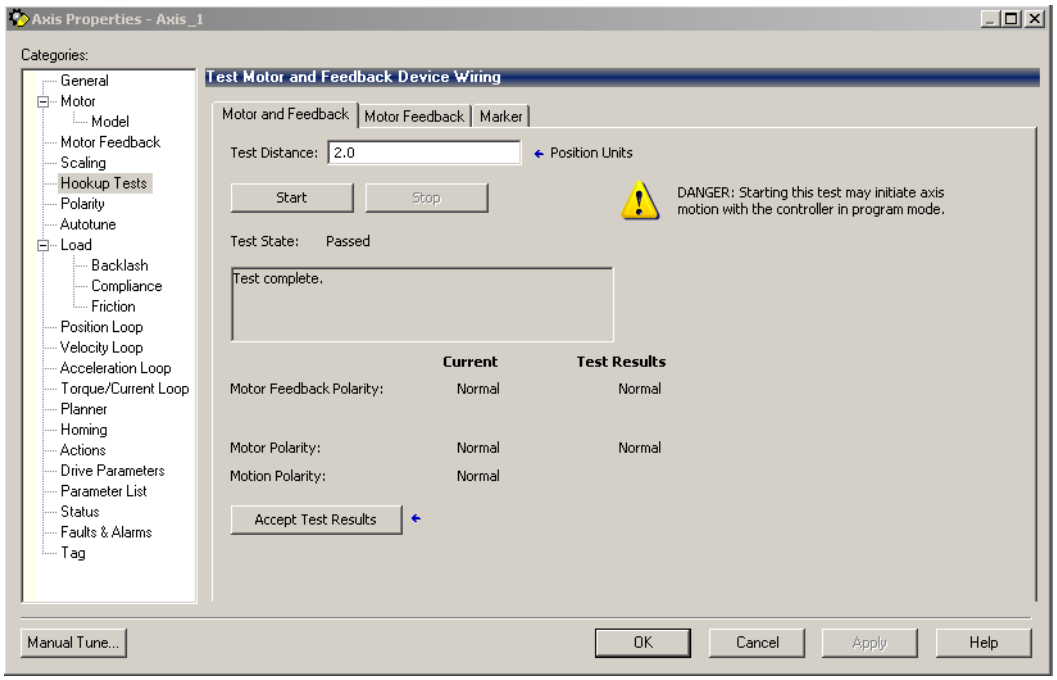
Test the Axes

Follow these steps to test the axes.

1. Verify the load was removed from each axis.
2. Right-click an axis in your Motion Group folder and choose Properties.

   The Axis Properties dialog box opens.

3. Click the Hookup Tests category.



4. Type 2.0 as the number of revolutions for the test or another number more appropriate for your application.

This Test	Performs this Test
Marker	Verifies marker detection capability as you rotate the motor shaft.
Motor Feedback	Verifies feedback connections are wired correctly as you rotate the motor shaft.
Motor and Feedback	Verifies motor power and feedback connections are wired correctly as you command the motor to rotate.

5.

If drive ENABLE is	Then
Hard wired	Apply 24V DC
Not used	Disable enableInputChecking using procedure on page 98

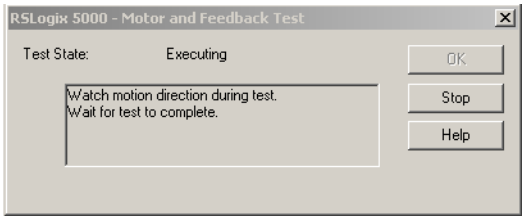
ATTENTION: To avoid personal injury or damage to equipment, apply 24V ENABLE signal only to the axis you are testing.

6. Click the desired tab (Marker/Motor Feedback/Motor and Feedback).

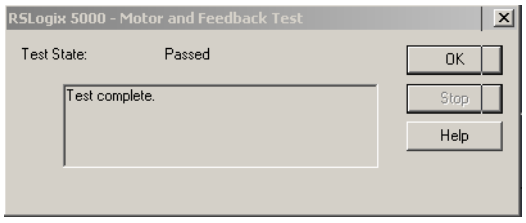
   In this example, the Motor and Feedback test is chosen.

7. Click Start.

The RSLogix 5000 - Motor and Feedback Test dialog box opens. The Test State is Executing.

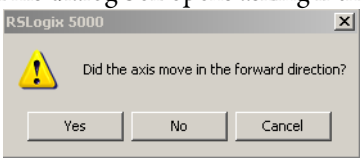


When the test completes successfully, the Test State changes from Executing to Passed.



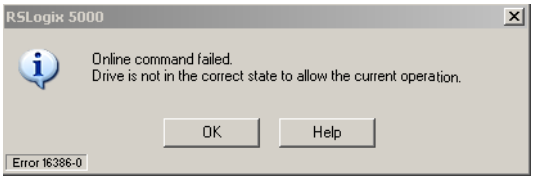
8. Click OK.

This dialog box opens asking if the direction was correct.



9. Click Yes.

If the test fails, this dialog box opens.



a. Click OK.
b. Verify the Axis status indicator turned solid green during the test.
c. Verify that the drive ENABLE signal is applied to the axis you are testing or that the enableInputChecking attribute is set to zero.
d. Verify the unit values entered in the Scaling category.
e. Return to main step 6 and run the test again.

Tune the Axes

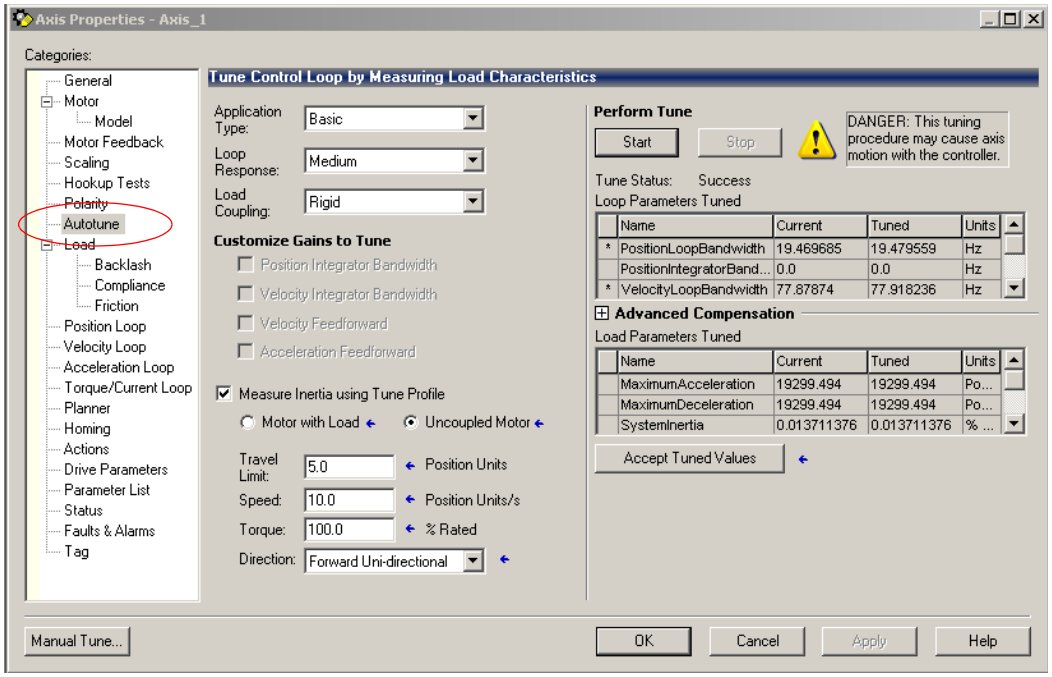
This is a basic procedure for simple systems. If you have a complicated system refer to CIP Motion Configuration and Startup User Manual, publication Motion-UM003.

Follow these steps to tune the axes.

1. Verify the load is still removed from the axis being tuned.

> **ATTENTION:** To reduce the possibility of unpredictable motor response, tune your motor with the load removed first, then re-attach the load and perform the tuning procedure again to provide an accurate operational response.

2. Click the Autotune category.



3. Type values for Travel Limit and Speed.

   In this example, Travel Limit = 5 and Speed = 10. The actual value of programmed units depend on your application.

4. From the Direction pull-down menu, choose a setting appropriate for your application.

   Forward Uni-directional is default.

5. Edit other fields as appropriate for your application and click Apply.

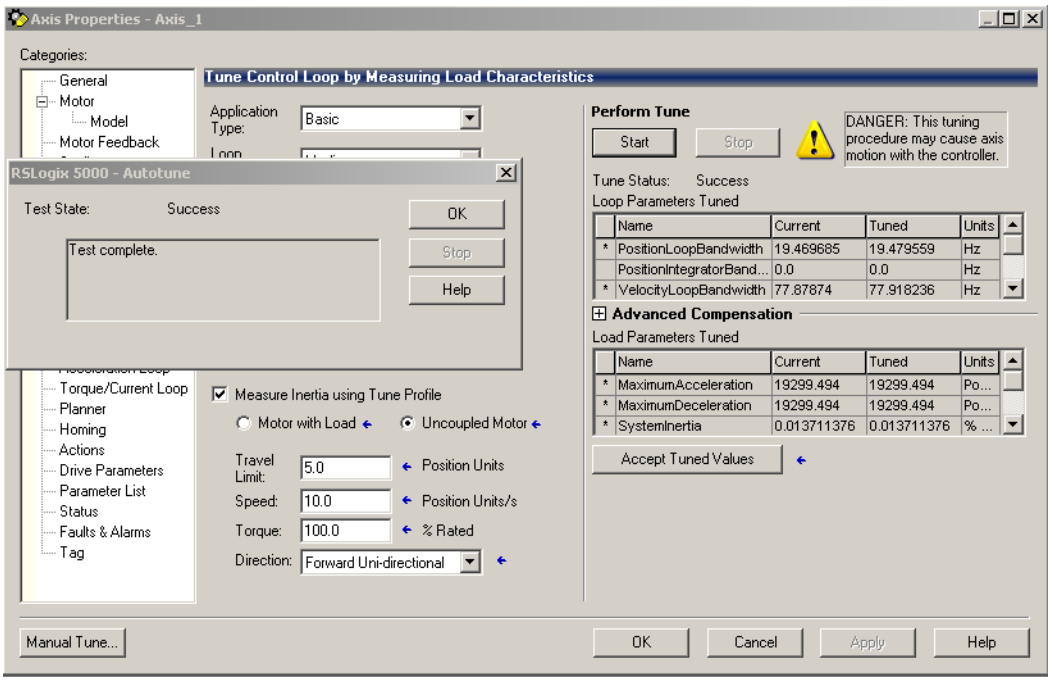
6.

If drive ENABLE is	Then
Hard wired	Apply 24V DC
Not used	Disable enableInputChecking using procedure on page 98

ATTENTION: To avoid personal injury or damage to equipment, apply 24V ENABLE signal only to the axis you are testing.

7. Click Start.

   The RSLogix - Autotune dialog box opens. When the test completes, the Test State changes from Executing to Success.



   Tuned values populate the Loop and Load parameter tables. Actual bandwidth values (Hz) depend on your application and may require adjustment once motor and load are connected.

   At this point, you can compare existing and tuned values for your gains and inertias with the prospective tune values.

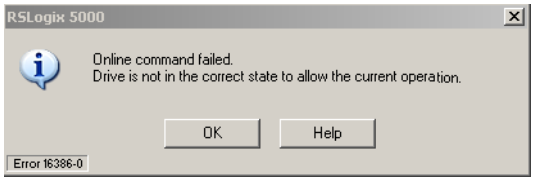
8. Accept the new values and apply them to the controller.

   Now you can run the system with the new gain set and evaluate performance. You can improve the performance by adjusting application type, loop response, and/or load coupling selections.

   TIP If your application requires stricter performance you can further improve performance with manual tuning.

9. Click OK to close the RSLogix 5000 - Autotune dialog box.
10. Click OK to close the Axis Properties dialog box.

11. If the test fails, this dialog box opens.



a. Click OK.

b. Make an adjustment to motor velocity.

c. Refer to the appropriate Logix motion module user manual for more information.

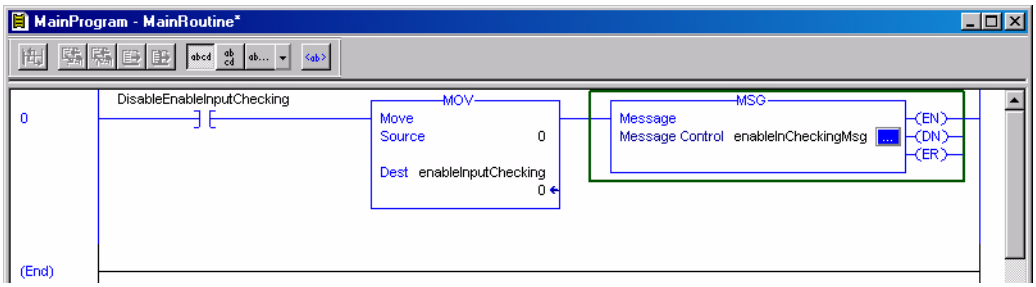
d. Return to step 7 and run the test again.

12. Repeat Test and Tune the Axes for each axis.

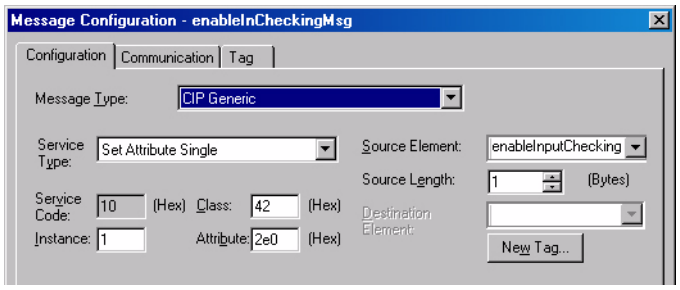
Disable EnableInputChecking Using a RSLogix Message Instruction

This procedure sends a Logix message to disable the EnableInputChecking attribute in the Kinetix 350 drive.

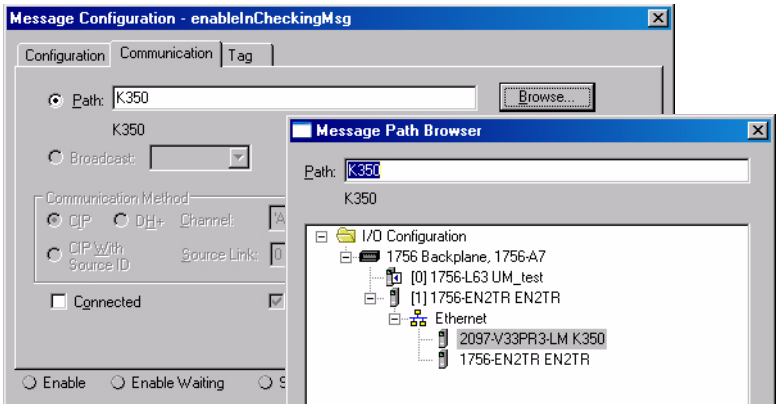
1. From the Controller Organizer, choose Tasks>MainTask>MainProgram>MainRoutine.
2. Create a MSG instruction rung as shown.



3. Set the values in the Message Configuration as shown.



4. Click the Communications tab and browse to the drive tag, in this case K350, as shown.



5. When the program is in Run mode, trigger the rung to run the instruction.

   The drive will not check the enable input signal on IOD-29 Enable to IOD -26 Common. This MSG instruction only needs to be executed once as it is a persistent type instruction and gets saved to the drive Non-volatile Memory. To re-enable enable input signal checking on IOD-29 Enable to IOD-26 Common, change the Source Element register, enableinputChecking from 0 to 1 and trigger the run again.

Kinetix 350 Drive Safe Torque-off Feature

Introduction

This chapter introduces you to how the safe torque-off feature meets the requirements for ISO 13849-1 performance level d (PLd) safety category 3.

Certification

The safe torque-off circuit is type-approved and certified for use in safety applications up to and including ISO 13849-1 performance level d (PLd) safety category 3.

The TÜV Rheinland group has approved the Kinetix 350 drives for use in safety-related applications up to ISO 13849-1 performance level d (PLd) safety category 3, in which the de-energized state is considered to be the safe state. All of the examples related to I/O included in this manual are based on achieving de-energization as the safe state for typical machine safety systems.

Important Safety Considerations

The system user is responsible for the following:

- Validation of any sensors or actuators connected to the drive system
- Completing a machine-level risk assessment
- Certification of the machine to the desired ISO 13849-1 performance level
- Project management and proof testing
- Programming the application software and the device configurations in accordance with the information in this safety reference manual and the drive product manual

Safety Category 3 Requirements

Safety-related parts are designed with these attributes:

- A single fault in any of these parts does not lead to the loss of the safety function
- A single fault is detected whenever reasonably practicable
- Accumulation of undetected faults can lead to the loss of the safety function.

Stop Category Definition

Stop category 0 is achieved with immediate removal of power to the actuator.

IMPORTANT	In the event of drive or control failure, the most likely stop category is category 0. When designing the machine application, consider timing and distance for a coast to stop. For more information regarding stop categories, refer to EN 60204-1.

Performance Level and Safety Integrity Level (SIL) CL2

For safety-related control systems, Performance Level (PL), according to ISO 13849-1, and SIL levels, according to EN 61508 and EN 62061, include a rating of the systems ability to perform its safety functions. All of the safety-related components of the control system must be included in both a risk assessment and the determination of the achieved levels.

Refer to the ISO 13849-1, EN 61508, and EN 62061 standards for complete information on requirements for PL and SIL determination.

Description of Operation

The safe torque-off feature provides a method, with sufficiently low probability of failure on demand, to force the power-transistor control signals to a disabled state. When disabled, or any time power is removed from the safety enable inputs, all of the drives output-power transistors are released from the ON state, effectively removing motive power generated by the drive. This results in a condition where the motor is in a coasting condition (stop category 0). Disabling the power transistor output does not provide mechanical isolation of the electrical output, which may be required for some applications.

Under normal drive operation, the safe torque-off switches are energized. If either of the safety enable inputs are de-energized, the gate control circuit is disabled. To meet ISO 13849-1 (PLd) both safety channels must be used and monitored.

ATTENTION: Permanent magnet motors may, in the event of two simultaneous faults in the IGBT circuit, result in a rotation of up to 180 electrical degrees.

Functional Proof Tests

The functional safety standards require that functional proof tests be performed on the equipment used in the system. Proof tests are performed at user-defined intervals, not to exceed one year, and are dependent upon PFD and PFH values.

IMPORTANT Users specific applications determine the time frame for the proof test interval, but it must not exceed one year due to the use of switches internal to the drive, as required by ISO 13849-1.

To proof test the safe torque-off function, you must interrupt power to the inputs of the safe torque-off function at pins STO-4 and STO-6 and verify that the drive is in the disabled state.

Table 35 - Proof Test Truth Table

Safety Function State	Safety Input 1 (STO-4)	Safety Input 2 (STO-6)	Safety Status Output (STO-3)
Normal operation	Energized	Energized	Energized
Safe torque-off mismatch	Energized	De-energized	Energized
	De-energized	Energized	Energized
Safe torque-off function engaged	De-energized	De-energized	De-energized

Normal operation of the safe torque-off function, if monitored and verified, constitutes the proof test.

Troubleshooting the Safe Torque-off Function

ATTENTION: The safe torque-off fault is detected upon demand of the safe torque-off function. After troubleshooting, a proof test must be performed to verify correct operation.

PFD and PFH Definitions

Safety-related systems can be classified as operating in either a Low Demand mode, or in a High Demand/Continuous mode:

- Low Demand mode: where the frequency of demands for operation made on a safety-related system is no greater than one per year or no greater than twice the proof-test frequency.
- High Demand/Continuous mode: where the frequency of demands for operation made on a safety-related system is greater than once per year or greater than twice the proof test interval.

The SIL value for a low demand safety-related system is directly related to order-of-magnitude ranges of its average probability of failure to satisfactorily perform its safety function on demand or, simply, average probability of failure on demand (PFD). The SIL value for a High Demand/Continuous mode safety-related system is directly related to the probability of a dangerous failure occurring per hour (PFH).

PFD and PFH Data

These PFD and PFH calculations are based on the equations from EN 61508 and show worst-case values.

This table provides data for a 20-year proof test interval and demonstrates the worst-case effect of various configuration changes on the data.

Table 36 - PFD and PFH for 20-year Proof Test Interval

Attribute	Value
PFH [1e-9]	5.9
PFD [1e-3]	1.0

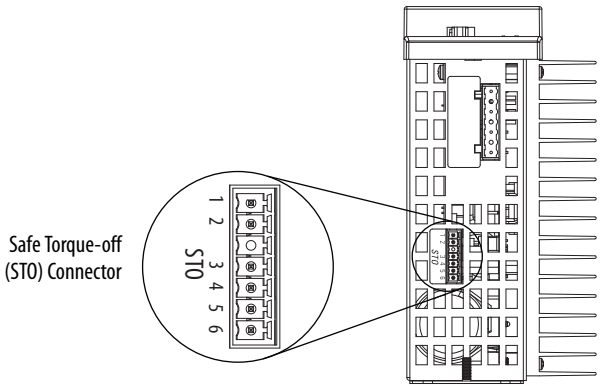
Safe Torque-off Connector Data

This section provides safe torque-off (STO) connector and header information for the Kinetix 350 drive safe torque-off.

STO Connector Pinouts

Headers extend the STO connector signals for use in wiring or to defeat (not use) the safe torque-off function.

Figure 45 - 6-pin Safe Torque-off (STO) Connector



Kinetix 350 Drive, Bottom View
(2097-V32PR4-LM is shown)

STO Pin	Description	Signal
1	+24V DC output from the drive	+24V DC control
2	+24V DC output common	Control COM
3	Safety status	Safety Status
4	Safety input 1 (+24V DC to enable)	Safety Input 1
5	Safety common	Safety COM
6	Safety input 2 (+24V DC to enable)	Safety Input 2

Wiring Your Safe Torque-off Circuit

This section provides guidelines for wiring your Kinetix 350 safe torque-off drive connections.

European Union Directives

If this product is installed within the European Union or EEC regions and has the CE mark, the following regulations apply.

For more information on the concept of electrical noise reduction, refer to System Design for Control of Electrical Noise Reference Manual, publication GMC-RM001.

EMC Directive

This unit is tested to meet Council Directive 2004/108/EC Electromagnetic Compatibility (EMC) by using these standards, in whole or in part:

- EN 61800-3 - Adjustable Speed Electrical Power Drive Systems, Part 3 - EMC Product Standard including specific test methods
- EN 61000-6-4 EMC - Emission Standard, Part 2 - Industrial Environment
- EN 61000-6-2 EMC - Immunity Standard, Part 2 - Industrial Environment

The product described in this manual is intended for use in an industrial environment.

CE Conformity

Conformity with the Low Voltage Directive and Electromagnetic Compatibility (EMC) Directive is demonstrated by using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. The safe torque-off circuit complies with the EN standards when installed according instructions found in this manual.

CE Declarations of Conformity are available online at: http://www.rockwellautomation.com/products/certification/ce.

Low Voltage Directive

These units are tested to meet Council Directive 2006/95/EC Low Voltage Directive. The EN 60204-1 Safety of Machinery-Electrical Equipment of Machines, Part 1-Specification for General Requirements standard applies in whole or in part. Additionally, the standard EN 50178 Electronic Equipment for use in Power Installations apply in whole or in part.

Safe Torque-off Wiring Requirements

These are the safe torque-off (STO) wiring requirements. Wire should be copper with 75 °C (167 °F) minimum rating.

IMPORTANT The National Electrical Code and local electrical codes take precedence over the values and methods provided.

IMPORTANT Stranded wires must terminate with ferrules to prevent short circuits, per table D7 of EN 13849.

Figure 46 - Safe Torque-off (STO) Terminal Plug

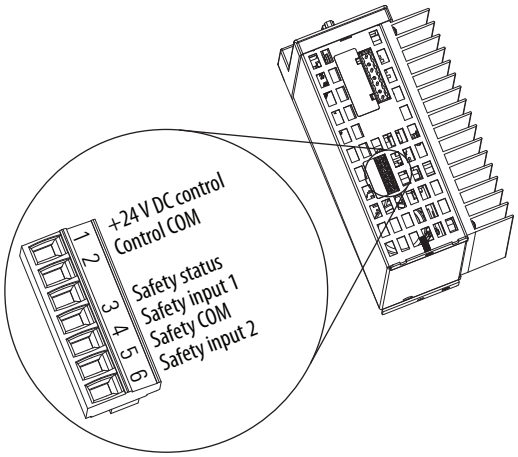


Table 37 - Safe Torque-off (STO) Terminal Plug Wiring

Safe Torque-off (STO) Connector		Recommended Wire Size		Strip Length mm (in.)	Torque Value N•m (lb•in)
Pin	**Signal**	**Stranded Wire with Ferrule** mm^2 (AWG)	**Solid Wire** mm^2 (AWG)		
STO-1 STO-2 STO-3 STO-4 STO-5 STO-6	+24V DC Control Control COM Safety Status Safety Input 1 Safety COM Safety Input 2	0.75 (18)	1.5 (16)	6 (0.25)	0.2 (1.8)

IMPORTANT Pins STO-1 (+24V DC Control) and STO-2 (Control COM) are used only by the motion-allowed jumpers to defeat the safe torque-off function. When the safe torque-off function is in operation, the 24V supply must come from an external source.

IMPORTANT To be sure of system performance, run wires and cables in the wireways as established in the user manual for your drive.

Kinetix 350 Drive Safe Torque-off Feature

The safe torque-off circuit, when used with suitable safety components, provides protection according to ISO 13849-1 (PLd). The safe torque-off option is just one safety control system. All components in the system must be chosen and applied correctly to achieve the desired level of operator safeguarding.

The safe torque-off circuit is designed to safely remove power from the gate firing circuits of the drives output power devices (IGBTs). This prevents them from switching in the pattern necessary to generate AC power to the motor.

You can use the safe torque-off circuit in combination with other safety devices to meet the stop and protection-against-restart requirements of ISO 13849-1.

ATTENTION: This option is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety.

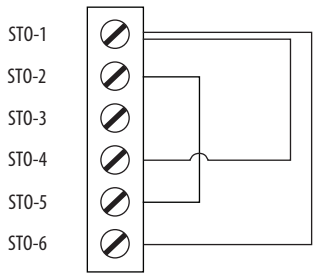
SHOCK HAZARD: In Safe Torque-off mode, hazardous voltages may still be present at the motor. To avoid an electric shock hazard, disconnect power to the motor and verify that the voltage is zero before performing any work on the motor.

Safe Torque-off Feature Bypass

The drive is supplied from the factory with the safe torque-off circuit enabled. The drive is not operational until +24V is present at terminals STO-4 and STO-6. When safety connections are not required, the drive can be operated with the safety circuit disabled.

Use jumper wires, as shown, to defeat the safe torque-off function.

Figure 47 - STO Motion-allowed Jumpers



IMPORTANT Pins STO-1 (+24V DC Control) and STO-2 (Control COM) are used only by the motion-allowed jumpers to defeat the safe torque-off function. When the safe torque-off function is in operation, the 24V supply must come from an external source.

Kinetix 350 Drive Safe Torque-off Wiring Diagrams

This section provides typical wiring diagrams for the Kinetix 350 drive safe torque-off feature with other Allen-Bradley safety products.

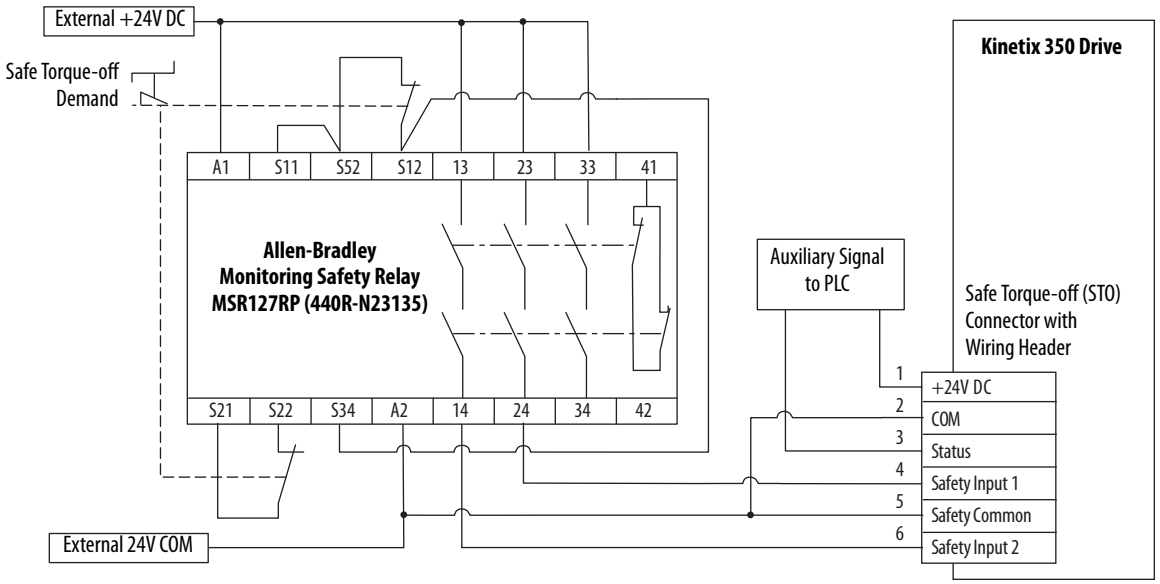
For additional information regarding Allen-Bradley safety products, including safety relays, light curtain, and gate interlock applications, refer to the Safety Products Catalog, website http://www.ab.com/catalogs.

The drive is shown in a single-axis relay configuration for category 0 stop per EN-60204-1 Safety of Machinery Directive. These are examples, however, and user applications can differ based on the required overall machine performance level requirements.

IMPORTANT The Kinetix 350 drive meets the requirements of ISO 13849-1 Safety of Machinery, Safety-related Parts of Control Systems, category (CAT 3), performance level (PL)d and Safety Integrity Level (SIL) 2 per EN 61800-5-2:2007. Dual inputs and drive monitoring of the safe torque-off circuit, STO-4 and STO-6, are done to prevent drive enable should either or both of these inputs not function.

It is suggested to evaluate the entire machine performance level required with a risk assessment and circuit analysis. Contact your local distributor or Rockwell Automation Sales for more information.

Figure 48 - Single-axis Relay Configuration (Stop Category 0) with Automatic Reset



Safe Torque-off Signal Specifications

This table provides specifications for the safe torque-off signals used in the Kinetix 350 servo drives.

Attribute	Value
Safety inputs (1)	Insulated, compatible with single-ended output (+24V DC)
	Enable voltage range: 20…24V DC
	Disable voltage range: 0…1.0V DC
Input impedance	6.8 kΩ
Safety status	Isolated Open Collector (Emitter is grounded.)
Output load capability	100 mA
Digital outputs max voltage	30V DC

(1) Safety inputs are not designed for pulse testing.

Troubleshoot the Kinetix 350 Drive

Introduction

This chapter provides troubleshooting tables for your Kinetix 350 drive.

Safety Precautions

Observe the following safety precautions when troubleshooting your Kinetix 350 drive.

ATTENTION: Capacitors on the DC bus may retain hazardous voltages after input power has been removed. Before working on the drive, measure the DC bus voltage to verify it has reached a safe level or wait the full time interval as indicated in the warning on the front of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: Do not attempt to defeat or override the drive fault circuits. You must determine the cause of a fault and correct it before you attempt to operate the system. Failure to correct the fault could result in personal injury and/or damage to equipment as a result of uncontrolled machine operation.

ATTENTION: Provide an earth ground for test equipment (oscilloscope) used in troubleshooting. Failure to ground the test equipment could result in personal injury.

Interpret Status Indicators

Refer to these troubleshooting tables to identify faults, potential causes, and the appropriate actions to resolve the fault. If the fault persists after attempting to troubleshoot the system, please contact your Rockwell Automation sales representative for further assistance.

Four-digit Display Messages

The control modules include a four-digit seven-segment display for status and fault messages. The display scrolls to display text strings.

The Four-digit Display Messages table lists the messages along with their priorities. When messages of different priorities need to be displayed, for example, when the drive has both a fault and a start inhibit, only the higher priority message is displayed. When messages of equal priority are needed, for example, when there is more than one fault, the messages are displayed in a round-robin fashion. Only two messages will be scrolled in this manner.When a fault is annunciated, the entire fault text will scroll on the display regardless of when the fault is cleared

The IP address is always an active condition, meaning that it will scroll in conjunction with the axis state as long as there are no higher priority messages to display.

Refer to the table on Four-digit Display Messages for a description of the messages that scroll across the display during powerup.

Table 38 - Four-digit Display Messages

Device Condition	Display Digit	Priority (lower is higher)
IP address (always active)	xxx.xxx.xxx.xxx	4
Executing device self-test	-08-	
Waiting for connection to controller	-00-	
Configuring device attributes	-01-	
Waiting for group synchronization	-02-	
Waiting for DC Bus to charge	-03-	
Device is operational	-04-	
Start inhibit code	S *xx*	3
Start inhibit code - custom	S*cxx*	
Axis fault code	F *xx*	2
Axis fault code - custom	F*cxx*	
Boot error	L*xxx*	1
Power on Self Test (POST) error	P*xxx*	
Initialization fault code - custom	I*cxx*	
Node fault code	nF*xx*	1

Fault Codes

These fault code tables are designed to help you resolve anomalies. When a fault is detected, the four-digit status indicator scrolls the display message. This is repeated until the fault code is cleared.

Table 39 - Fault Code Summary

Fault Code Type	Description
S *xx*	Conditions that prevent the drive from enabling, see Table 40.
Sc*xx*	
F *xx*	Standard axis fault, see Table 41 and Table 42.
Fc*xx*	
L*xxx*	Unrecoverable errors that occur during the boot process. Return drive to Rockwell Automation.
P*xxx*	Unrecoverable errors that occurred during the Power on Self Test (POST). Return drive to Rockwell Automation.
Ic*xx*	Anomalies that prevent normal operation and occur during the initialization process.
nF*xx*	Anomalies that prevent normal operation of the drive. Node Fault. This type of fault that impacts the servo drive not just the axis of motion.

Table 40 - S *xx* and Sc*xx* Start Inhibit Codes

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
S 01	Axis enable input.	The axis enable input is deactivated.	Axis Enable Input is not active.	• Check wiring and 24V source for drive ENABLE Input. • Disable enableInputChecking attribute using a message instruction.
S 02	Motor not configured.	The associated motor has not been configured for use.	Faulty intelligent encoder or incorrect motor file.	• Cycle power or reset the drive. • Check proper motor has been selected in RSLogix software. • Replace motor if faulting continues.
S 03	Feedback not configured.	The associated feedback device has not been configured for use or the configuration does not match what is connected.		
Sc05	Safe torque off.	No power or safety circuitry not configured.	The safety function has disabled the power structure.	• Apply 24V sources to safety circuit. • Use jumpers to bypass safety circuit.

Table 41 - F *xx* Fault Codes

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
F 02	Illegal Hall State	State of Hall feedback inputs is incorrect.	Improper connections.	• Check wiring of S1,S2, and S3 • Check the power supply to the encoder.
F 03	Motor Overspeed	Motor speed has exceeded 125% of maximum rated speed.		• Check motor wire phasing. • Check cables for noise. • Check tuning.
F 05	Motor Overtemperature	The motor thermostat, motor thermistor, or encoder temperature sensor indicates that the motor factory temperature limit has been exceeded.	High motor ambient temperature and/or Excessive Current.	• Check motor wiring at motor feedback (MF) connector. • Check TS+ and COM wiring. • Operate within (not above) the continuous torque rating for the ambient temperature. • Lower ambient temperature or increase motor cooling. • Verify the proper motor has been selected.
F 07	Motor Thermal Protection	The thermal model for the motor indicates that the temperature has exceeded 110% of its rating.	The machine duty cycle requires an RMS current exceeding the continuous rating of the motor.	Change the command profile to reduce speed or increase time.
F 10	Inverter Overcurrent	The drive fault output indicates that the power transistors were turned off because of overcurrent, overtemperature, or power supply problems.	Motor cables shorted.	Verify continuity of motor power cable and connector.
			Motor winding shorted internally.	Disconnect motor power cables from the motor. Use multimeter to check that the resistance of phase-to-phase is not open and that phase-to-ground is open.
			The drive temperature is too high.	• Check for clogged vents or defective fan. • Make sure cooling is not restricted by insufficient space around the unit. • Verify ambient temperature is is within the specification. See Environmental Specifications on page 133.
			Operation above continuous power rating and/or product environmental ratings.	• Operate within the continuous power rating. • Reduce acceleration rates.
			The drive has a short circuit, overcurrent, or failed component.	Remove all power and motor connections, and preform a continuity check from the DC bus to the U, V, and W motor outputs. If a continuity exists, check for wire fibers between terminals, or send drive in for repair.
			Loss of TTL signal	Check AM+, AM -, BM +, and BM- signals.
F 11	Inverter Overtemperature	Inverter thermal switch tripped.	Drive fan failed.	Replace the failed drive.
			The cabinet ambient temperature is above rating.	Check the cabinet temperature. See Environmental Specifications on page 133
			The machine duty cycle requires an RMS current exceeding the continuous rating of the controller.	Change the command profile to reduce speed or increase time.
			The airflow access to the drive system is limited or blocked.	Check airflow and re-route cables away from the drive system.
F 13	Inverter Thermal Protection	The thermal model for the power transistors indicates that the temperature has exceeded 110% of its rating.	The machine duty cycle requires an RMS current exceeding the continuous rating of the controller.	Change the command profile to reduce speed or increase time.
			Motor brake on.	Turn motor brake off.

Table 41 - F *xx* Fault Codes (continued)

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
F 33	Bus Undervoltage	With three-phase power present, the DC bus voltage is below limits.	DC bus voltage for 460V system is below 275V. DC bus voltage for 230V system is below 137V. DC bus voltage for 120V system is below 80V	• Verify voltage level of the incoming AC power. • Check AC power source for glitches or line drop. • Install an uninterruptible power supply (UPS) on your AC input.
F 35	Bus Overvoltage	The DC bus voltage is measured above a factory limit.	Excessive regeneration of power.	Change the deceleration or motion profile.
			When the motor is driven by an external mechanical power source, it may regenerate too much peak energy through the drive power supply. The system faults to save itself from an overload.	Use a larger system (motor and drive).
			DC bus voltage for 460V system is over 820V.	Install shunt resistor.
F 43	Feedback Loss	• On sin/cos encoders, the sum of the square of the sin/cos signals has been measured below a factory limit. • On TTL encoders, the absolute value of the differential A/B signals is below a factory limit.	The motor feedback wiring is open, shorted, or missing.	• Check motor encoder wiring. • Run Hookup test in RSLogix 5000 software.
F 45	Feedback Serial Comms (TL-Series motors and actuators only)	The number of consecutive missed or corrupted serial data packets from the feedback device has exceeded a factory set limit.	Communication was not established with an intelligent encoder.	• Verify motor selection. • Verify motor encoder wiring.
F 47	Feedback Self Test	The feedback device has detected an internal error.	Damage to feedback device.	Call your Rockwell Automation sales representative to return motor for repair.
F 50	Hardware Overtravel - Positive	Axis moved beyond the physical travel limits in the positive direction.	Dedicated overtravel input is inactive.	• Check wiring. • Verify motion profile. • Verify axis configuration in software.
F 51	Hardware Overtravel - Negative	Axis moved beyond the physical travel limits in the negative direction.		
F 54	Excessive Position Error	Position error limit was exceeded.	Partial loss of feedback signals.	Check all wiring at motor feedback (MF) connector.
			Improperly sized drive or motor.	Verify sizing of system.
			Mechanical system out of specifications.	• Increase the feed forward gain. • Increase following error limit or time. • Check position loop tuning. • Verify mechanical integrity of system within specification limits. • Check motor power wiring.
F 55	Excessive Velocity Error	Velocity Error value of the velocity control loop has exceeded the configured value for Velocity Error Tolerance.	Partial loss of feedback signals.	Check all wiring at motor feedback (MF) connector.
			Improperly sized drive or motor.	• Increase velocity error limit or time. • Check velocity loop tuning. • Verify sizing of system.
			Mechanical system out of specifications.	• Increase velocity error limit or time. • Check velocity loop tuning. • Verify mechanical integrity of system within specification limits. • Check motor power wiring. • Reduce acceleration.

Table 41 - F *xx* Fault Codes (continued)

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
F 56	Overtorque Limit	Motor torque has exceeded a user-programmable setting.	• Overly aggressive motion profile. • Mechanical binding.	• Verify motion profile. • Verify Overtorque settings are appropriate. • Verify sizing of system. • Verify torque offset
			Mechanical system out of specifications.	Verify mechanical integrity of system within specification limits.
F 57	Undertorque Limit	Motor torque has fallen below a user-programmable setting.	• Improperly configured limit. • Improperly configured motion. • Improperly drive/motor sizing.	• Verify motion profile. • Verify Overtorque settings are appropriate. • Verify sizing of system.
			Mechanical system out of specifications.	Verify mechanical integrity of system within specification limits.
F 61	Drive Enable Input	The hardware enable input was deactivated while the drive was enabled. This is applicable only when drive enable input is used.	An attempt was made to enable the axis through software while the Drive Enable hardware input was inactive.	• Check wiring of drive enable input. • Check 24V source.
			The Drive Enable input transitioned from active to inactive while the axis was enabled.	Verify that Drive Enable hardware input is active whenever the drive is enabled through software.
F 62	Controller Initiated Exception	The controller has requested the drive to generate an exception.	User configured software overtravel.	• Move axis out of soft overtravel range. • Clear soft overtravel fault. • Check soft overtravel configuration. • Consult controller documentation.

Table 42 - Fc *xx* Fault Codes

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
Fc 02	Motor Voltage Mismatch	Motor voltage incompatible with drive voltage.	Wrong motor connected to drive.	Connect appropriate motor to drive.
Fc 05	Motor Encoder Battery Loss (applies to Bulletin TLY motors with B feedback)	The battery voltage on a battery-backed motor encoder is low enough such that a power loss has caused the absolute position to no longer be available.	Weak battery or poor battery connection.	• Replace battery. • Check battery connection.
Fc 06	Motor Encoder Battery Low (applies to Bulletin TLY motors with B feedback)	The battery voltage on a battery-backed motor encoder is low enough such that a power loss will cause the absolute position to be lost.		
Fc 14	Excessive Current Feedback Offset	Current in one or more phases has been lost or remains below a preset level.		Replace the drive.
Fc 26	Runtime Drive Error	The drive firmware encountered an unrecoverable runtime error.		• Cycle control power. • Replace drive.

Table 43 - Ic *xx* Fault Codes

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
Ic 01	Boot Block Check Sum Fault	The motor data stored in a smart encoder has a checksum error.	Faulty intelligent encoder.	• Cycle power or reset the drive. • Replace motor if faulting continues.
Ic 02	Motor Data Range Error	Data within a motor data blob is out of range.	Faulty intelligent encoder or incorrect motor file.	• Cycle power or reset the drive. • Check validity of the motion database. • Replace motor if faulting continues.
Ic 03	Motor Feedback Communication Startup	Communication with a smart encoder could not be established on the motor feedback port.	Incorrect motor selected or connected.	Check motor selection.
			Faulty wiring.	Check motor encoder wiring.
Ic 06	Motor Absolute Startup Speed	The motor absolute encoder was not able to accurately determine the position after powerup due to motor speed greater than 100 rpm.	Mechanical movement of machine causing excessive rotation of motor during powerup.	Allow machine motion to stop before powerup.

Status messages of the format L*xxx* indicate an unrecoverable error while starting the drive. Reload firmware and restart the drive, if status message repeats contact Rockwell Automation technical support to return drive for repair.

Table 44 - L*xxx* Fault Codes

Four-digit Display Message	Cause
L001	Identity block corrupted
L002	Firmware file load failed
L004	Firmware not programmed (drive is new)
L008	DSP load operation failed

Status messages of the format P*xxx* indicate an unrecoverable error during the Power on Self Test (POST). Contact Rockwell Automation technical support to return drive for repair.

Table 45 - P*xxx* Fault Codes

Four-digit Display Message	Cause
P001	SDRAM test failed
P002	FPGA load operation failed
P004	DPRAM Test failed
P005	DSP I/F to DPram - no DSP response
P006	I/F to DPram failed
P007	Firmware file md5 test failure

Table 46 - nF xx Fault Codes

Four-digit Display	RSLogix 5000 Fault Message	Problem or Symptom	Potential Cause	Possible Resolution
nF 01	Control Update Fault	Several consecutive updates from the controller have been lost.	Excessive network traffic.	• Remove unnecessary network devices from the motion network. • Change the network topology so that fewer devices share common paths. • Use faster/higher performance network equipment.
			Noisy environment.	• Segregate signal wiring from power wiring. • Use shielded cables. • Add snubbers to power devices.
nF 02	Processor Watchdog Fault	The watchdog circuit monitoring processor operation detected a problem.		• Recycle control power or reset the drive. • Replace control module if problem persists.
nF 03	Hardware Fault	The drive has an internal hardware problem.		• Recycle control power or reset the drive. • Replace drive.
		Nonvolatile write or write to memory failed.	Faulty memory component.	• Recycle control power or reset the drive. • Replace drive if problem persists.
nF 04	Data Format Error	A data format error was discovered in the controller-to-drive message.	Faulty memory component.	• Recycle control power or reset the drive. • Replace control module if problem persists.

Status Indicators

Table 47 - Drive Status Indicator

Status	Description
Off	No power. Apply power.
Alternating green/red	Self-test (power-up diagnostics). Wait for steady green.
Flashing green	Standby (device not configured). Wait for steady green.
Steady green	Normal operation, no faults.
Flashing red	Minor fault (recoverable). Refer to four-digit fault message.
Steady red	Major fault (non-recoverable). Refer to four-digit fault message.

Table 48 - Axis Status Indicator

Status	Description
Off	Off
Flash red/green	Self test
Off	Initialization - bus not up
Flashing green	Initialization - bus up
Off	Shutdown - bus not up
Flashing amber (1)	Shutdown - bus up
Off	Pre-charge - bus not up
Flashing amber (1)	Start inhibit
Flashing green (1) (2)	Stopped
Solid green (1) (2)	Stopping
	Starting
	Running
	Testing
Flashing red	Aborting
	Major faulted
Solid red	Aborting
	Major faulted

(1) The axis and the drive define minor fault conditions. While a minor fault does not affect the drive status indicator, it does affect the axis status indicator. When a minor fault condition is detected, a normally solid green status indicator indication changes to alternating red-green-red-green, a normally flashing green status indicator indication changes to alternating red-off-green-off, and a normally flashing amber indications changes to red-off-amber-off.

(2) The drive also defines alarm conditions. When an alarm condition is detected, a normally solid green status indicator indication changes to alternating amber-green-amber green while a normally flashing green status indicator indication changes to alternating amber-off-green-off.

Table 49 - Network Status Indicators

Status	Description
Off	No power or no IP address defined.
Alternating green/red	Self-test mode (power-up diagnostics).
Flashing green	Standby (device not configured, or connection not established.
Steady green	Normal operation. Device has at least one established connection.
Flashing red	Recoverable minor fault or connection timeout.
Steady red	Non-recoverable major fault or duplicate IP address.

IMPORTANT Under some fault conditions, two reset commands may be required to clear drive.

Table 50 - Port 1 Ethernet Communication Status Indicators

Status	Description
Off	No link partner present.
Flashing green	Link partner present, communication occurring.
Steady green	Link partner present, no communication occurring.

General System Behavior

These events do not always result in a fault code, but may require troubleshooting to improve performance.

Table 51 - General System Behavior

Condition	Potential Cause	Possible Resolution
Axis or system is unstable.	The position feedback device is incorrect or open.	Check wiring.
	Unintentionally in Torque mode.	Check to see what primary operation mode was programmed.
	Motor tuning limits are set too high.	Run Tune in RSLogix 5000 software.
	Position loop gain or position controller accel/decel rate is improperly set.	Run Tune in RSLogix 5000 software.
	Improper grounding or shielding techniques are causing noise to be transmitted into the position feedback or velocity command lines, causing erratic axis movement.	Check wiring and ground.
	Motor Select limit is incorrectly set (servo motor is not matched to axis module).	• Check setups. • Run Tune in RSLogix 5000 software.
	Mechanical resonance.	Notch filter or output filter may be required (refer to Axis Properties dialog box, Output tab in RSLogix 5000 software).
You cannot obtain the motor acceleration/deceleration that you want.	Torque Limit limits are set too low.	Verify that current limits are set properly.
	Incorrect motor selected in configuration.	Select the correct motor and run Tune in RSLogix 5000 software again.
	The system inertia is excessive.	• Check motor size versus application need. • Review servo system sizing.
	The system friction torque is excessive.	Check motor size versus application need.
	Available current is insufficient to supply the correct accel/decel rate.	• Check motor size versus application need. • Review servo system sizing.
	Acceleration limit is incorrect.	Verify limit settings and correct them, as necessary.
	Velocity Limit limits are incorrect.	Verify limit settings and correct them, as necessary.
Motor does not respond to a velocity command.	The axis cannot be enabled for 1.5 seconds after disabling.	Disable the axis, wait for 1.5 seconds, and enable the axis.
	Enable signal has not been applied or the enable wiring is incorrect.	• Check the controller. • Check the wiring.
	The motor wiring is open.	Check the wiring.
	The motor thermal switch has tripped.	• Check for a fault. • Check the wiring.
	The motor has malfunctioned.	Repair or replace the motor.
	The coupling between motor and machine has broken (for example, the motor moves, but the load/machine does not).	Check and correct the mechanics.
	Primary operation mode is set incorrectly.	Check and properly set the limit.
	Velocity or current limits are set incorrectly.	Check and properly set the limits.
Presence of noise on command or motor feedback signal wires.	Recommended grounding per installation instructions have not been followed.	• Verify grounding. • Route wire away from noise sources. • Refer to System Design for Control of Electrical Noise, publication GMC-RM001.
	Line frequency may be present.	• Verify grounding. • Route wire away from noise sources.
	Variable frequency may be velocity feedback ripple or a disturbance caused by gear teeth or ballscrew balls, and so forth. The frequency may be a multiple of the motor power transmission components or ballscrew speeds resulting in velocity disturbance.	• Decouple the motor for verification. • Check and improve mechanical performance, for example, the gearbox or ballscrew mechanism.

Table 51 - General System Behavior

Condition	Potential Cause	Possible Resolution
No rotation	The motor connections are loose or open.	Check motor wiring and connections.
	Foreign matter is lodged in the motor.	Remove foreign matter.
	The motor load is excessive.	Verify the servo system sizing.
	The bearings are worn.	Return the motor for repair.
	The motor brake is engaged (if supplied).	• Check brake wiring and function. • Return the motor for repair.
	The motor is not connect to the load.	Check coupling.
Motor overheating	The duty cycle is excessive.	Change the command profile to reduce accel/decel or increase time.
	The rotor is partially demagnetized causing excessive motor current.	Return the motor for repair.
Abnormal noise	Motor tuning limits are set too high.	Run Tune in RSLogix 5000 software.
	Loose parts are present in the motor.	• Remove the loose parts. • Return motor for repair. • Replace motor.
	Through bolts or coupling is loose.	Tighten bolts.
	The bearings are worn.	Return motor for repair.
	Mechanical resonance.	Notch filter may be required (refer to Axis Properties dialog box, Output tab in RSLogix 5000 software).
Erratic operation - Motor locks into position, runs without control or with reduced torque.	Motor power phases U and V, U and W, or V and W reversed.	Check and correct motor power wiring.
	Sine, Cosine or Rotor leads are reversed in the feedback cable connector.	Check and correct motor feedback wiring.
	Sine, Cosine, Rotor lead sets of resolver feedback are reversed.	Check and correct motor feedback wiring.

Logix Controller and Drive Behavior

By using RSLogix 5000 software, you can configure how the Bulletin 2097 drives respond when a drive fault/exception occurs.

TIP The I*xx* faults are always generated after powerup, but before the drive is enabled, so the stopping behavior does not apply.

Kinetix 350 Drive Exception Behavior

For Kinetix 350 drives, you can configure exception behavior in RSLogix 5000 software from the Axis Properties dialog box, Actions category.

Table 52 - Kinetix 350 Drive Exception Action Definitions

Exception Action	Definition
Ignore	The controller completely ignores the exception condition. For some exceptions that are fundamental to the operation of the planner, Ignore will not be an available option.
Alarm	The controller sets the associated bit in the Motion Alarm Status word but does not otherwise affect axis behavior. Like Ignore, if the exception is so fundamental to the drive, Alarm will not be an available option. When an exception action is set to Alarm, the Alarm will go away by itself when the exceptional condition has cleared.
Fault Status Only	Fault Status Only instructs the controller to set the associated bit in the Motion Fault Status word, but does not otherwise affect axis behavior. However, an explicit Fault Reset is required to clear the fault once the exceptional condition has cleared. If the exception is so fundamental to the drive, Fault Status Only will not be an available option.
Stop Planner	The controller sets the associated bit in the Motion Fault Status word and instructs the Motion Planner to perform a controlled stop of all planned motion at the configured maximum deceleration rate. An explicit Fault Reset is required to clear the fault once the exceptional condition has cleared. If the exception is so fundamental to the drive, Stop Planner will not be an available option.
Stop Drive	When the exception occurs, the associated bit in the Fault Status word is set and the axis will come to a stop by using the stopping action defined by the drive for the particular exception that occurred. There is no controller based configuration to specify what the stopping action is, the stopping action is device dependent.
Shutdown	When the exception occurs, the drive brings the motor to a stop by using the stopping action defined by the drive (as in Stop Drive) and the power module is disabled. Optionally, if the Shutdown Action attribute is configured for Drop DC Bus, the contactor will open. An explicit Shutdown Reset is required to restore the drive to operation.

Only selected drives faults can be configured. In the Drive Behavior, F xx Fault Codes tables, the controlling attribute is given for programmable fault actions.

Figure 49 - RSLogix 5000 Axis Properties - Actions Category

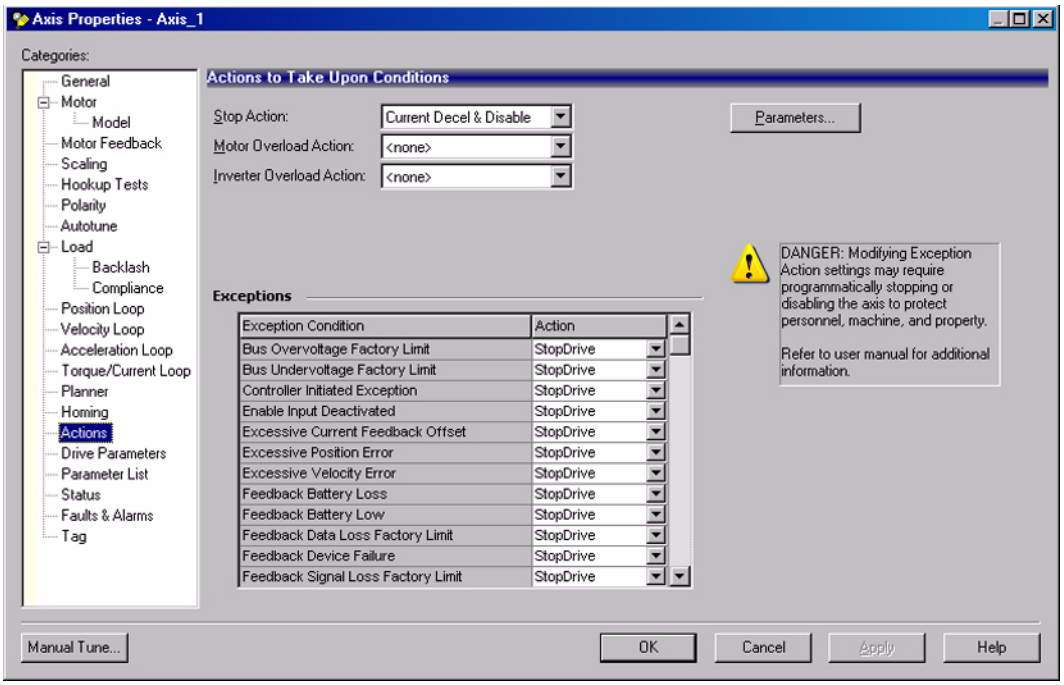


Table 53 - Drive Behavior, F *xx* Fault Codes

Four-digit Display	Exception	Description	Best Stopping Method (major fault only)
F 02	Motor Commutation	Permanent magnet motor commutation problem detected. Example would be an illegal state 111 or 000 for a UVW commutation device. This exception is supported only for TTL motors with Hall sensors.	Disable/Coast
F 03	Motor Overspeed	Motor speed has exceeded its maximum limit given by the Motor Overspeed Factory Limit attribute associated with the motor type. This exception triggers when either the electrical frequency exceeds 500 Hz or the motor is command to go 125% of its max rated speed.	Disable/Coast
F 05	Motor Overtemperature	Motor temperature has exceeded its factory set temperature limit given by Motor Overtemperature Factory Limit, or the integral motor thermal switch has tripped.	Disable/Coast
F 07	Motor Thermal Overload	Motor thermal model has exceeded its factory set thermal capacity limit given by Motor Thermal Overload Factory Limit. This limit is 108 °C (226 °F) for the Kinetix 350 drive.	Decel/Disable
F 10	Inverter Overcurrent	Inverter current has exceeded the factory set peak or instantaneous current limit. This limit is set to 450% of the rated drive current for a single phase.	Disable/Coast
F 11	Inverter Overtemperature	Inverter temperature has exceeded its factory set temperature limit given by Inverter Overtemperature Factory Limit. Detected when an internal temperature sensor senses 108 °C (226 °F).	Disable/Coast
F 13	Inverter Thermal Overload	Inverter thermal model has exceeded its factory set thermal capacity limit given by Inverter Thermal Overload Factory Limit. This threshold is set to 108 °C (226 °F).	Disable/Coast
F 33	Bus Undervoltage	DC Bus voltage level is below the factory set limit given by Bus Undervoltage Factory Limit. This limit is set at 75% of the nominal voltage as determined on powerup.	Decel/Disable
F 35	Bus Overvoltage	DC Bus voltage level is above the factory set limit given by Bus Overvoltage Factory Limit. For 240V drives the limit is 420V. For 480V drives, the limit is 840V.	Disable/Coast

Table 53 - Drive Behavior, F *xx* Fault Codes (continued)

Four-digit Display	Exception	Description	Best Stopping Method (major fault only)
F 43 (1)	Feedback Signal Loss	One or more A/B channel signals from a feedback device are open, shorted, missing, or severely attenuated. Specifically, the detected voltage levels of the signals are below the Feedback Signal Loss Factory Limit. The offending feedback channel is encoded in the associated Fault/Alarm Sub Code.	Disable/Coast
F 45	Feedback Data Loss	The number of consecutive missed or corrupted serial data packets over the serial data channel from a feedback device has exceeded the Feedback Data Loss Factory Limit. The offending feedback channel is encoded in the associated Fault/Alarm Sub Code. The threshold is set at four misses.	Disable/Coast
F 47	Feedback Device Failure	The feedback device has detected an internal error. Stegmann encoders return an error code and Tamagawa encoders have an error flag.	Disable/Coast
F 50	Hardware Overtravel Positive	Axis moved beyond the physical travel limits in the positive direction and activated the Positive Overtravel limit switch.	Decel/Disable
F 51	Hardware Overtravel Negative	Axis moved beyond the physical travel limits in the negative direction and activated the Negative Overtravel limit switch.	Decel/Disable
F 54 (1)	Excessive Position Error	The Position Error value of the position control loop has exceeded the configured value for Position Error Tolerance.	Decel/Disable
F 55 (1)	Excessive Velocity Error	The Velocity Error value of the velocity control loop has exceeded the configured value for Velocity Error Tolerance.	Decel/Disable
F 56	Overtorque Limit	Motor torque has risen above user defined maximum torque level given by Overtorque Limit.	Decel/Disable
F 57	Undertorque Limit	Motor torque has dropped below user defined minimum torque level given by Undertorque Limit.	Decel/Disable
F 61	Enable Input Deactivated	Enable has been deactivated while the axis is in Running state.	Decel/Disable
F 62	Controller Initiated Exception	Exception generated specifically by controller.	Disable/Coast

(1) When a TTL encoder loses its A/B signals it is not detected directly. Instead a secondary fault to detect the condition, typically excessive position or velocity error. In this case the motor will coast to a stop, but will still be enabled in RSLogix software.

IMPORTANT The fault detection ability of TTL encoders is not as advanced as with Stegmann hiperface or Tamagawa 17-bit serial encoders. When a TTL encoder loses its A/B signals, the Kinetix 350 drive is unable to detect this directly. Instead it relies on a secondary fault to detect the condition, typically excessive position or velocity error. There are some cases, particularly in Torque mode where the fault isn't detected at all. In this case the motor will coast to a stop, but will still be enabled in RSLogix software.

Table 54 - Drive Behavior, Fc*xx* Custom Fault Codes

Four-digit Display	Exception	Description	Best Stopping Method (Major Fault Only)
Fc02	Motor Voltage Mismatch	The motor voltage is incompatible with the applied drive voltage.	Disable/Coast
Fc05	Feedback Battery Loss	The battery voltage on a battery-backed motor encoder is low enough such that absolute position is not longer available. This occurs when the battery is too low and encoder main power has been removed.	Decel/Disable
Fc06	Feedback Battery Low	The battery voltage on a battery-backed motor encoder is below a caution level. This occurs when the battery is too low, but main power has not yet been removed.	Decel/Disable

Table 54 - Drive Behavior, Fc*xx* Custom Fault Codes

Four-digit Display	Exception	Description	Best Stopping Method (Major Fault Only)
Fc14	Excessive Current Feedback Offset	Current in one or more phases has been lost or remains below a preset level.	Disable/Coast
Fc26	Runtime Error	Runtime Assertions detected.	Disable/Coast
Fc63	Product Specific	Product Specific (exotic) exceptions by Sub Code.	Disable/Coast

A node fault is a fault that impacts the whole drive.

Table 55 - Drive Behavior, nF*xx* Node Fault Codes

Four-digit Display	Name	Description	Best Stopping Method
nF01	Control Connection Update Fault	The Control Connection Update Fault code is used to indicate that updates from the controller over the controller to drive connection have been excessively late as determined by the Controller Update Delay High Limit attribute value.	Disable/Coast
nF02	Processor Watchdog Fault	The Processor Watchdog Fault code indicates that the processor associated with the device node has experienced an excessive overload condition that has tripped the associated processor watchdog mechanism.	Disable/Coast
nF03	Hardware Fault	The Hardware Fault code indicates that the critical support hardware such as the FPGA or ASIC associated with the device node has experienced a fault condition. This will occur when the EPM module has been removed.	Disable/Coast
nF04	Data Format Error	This fault code indicates that an error has occurred in the data format between the controller and the device, such as a Format Revision mismatch.	Disable/Coast
nF06	Control Connection Loss Fault	The Control Connection Loss fault code indicates that the Motion controller to drive connection from the controller has timed out.	Disable/Coast

Web Server Interface

The Kinetix 350 drive supports a basic web interface for common status reporting and network configuration attributes. No attributes are configurable from this page. To access the page open a web browsers program and enter the IP address of the drive.

Figure 50 - Main Page

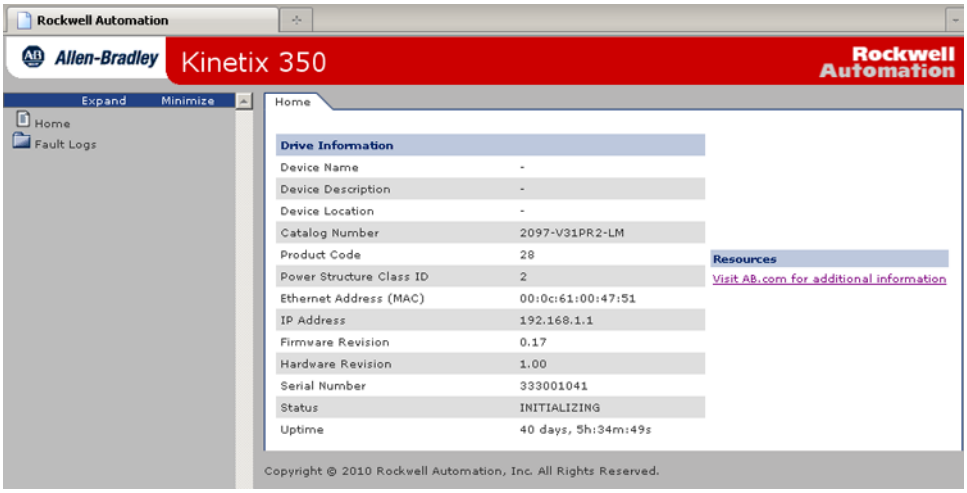
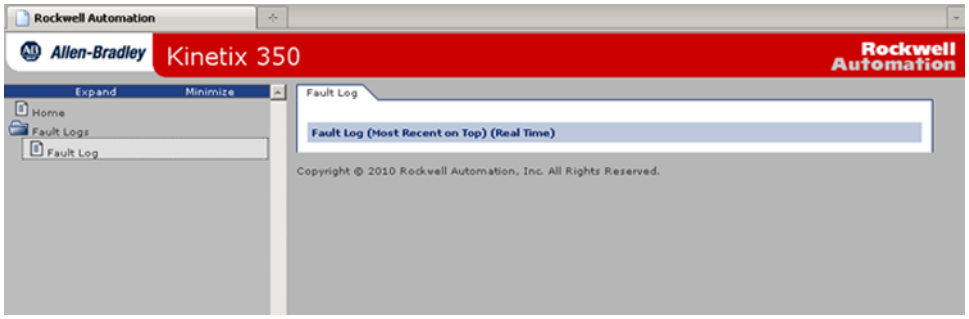


Figure 51 - Fault Page



Notes:

Specifications and Dimensions

Introduction

This appendix provides product specifications and mounting dimensions for your Kinetix 350 drive system components.

Kinetix 350 Drive Power Specifications

This section contains power specifications for your Kinetix 350 drive system components.

The 2097-V31PR*x*-LM drives with 120V input are capable of driving 240V motors at full speed.

Table 56 - Kinetix 350 Drive (single-phase) Power Specifications

Attribute	2097-V31PR0-LM	2097-V31PR2-LM	2097-V32PR0-LM	2097-V32PR2-LM	2097-V32PR4-LM
AC input voltage	70…132V rms single-phase (120V nom) 80…264V rms single-phase (240V nom)		80…264V rms single-phase (240V nom)		
AC input frequency	48…62 Hz				
Main AC input current (1)					
Nom (rms) 120V input (voltage doubler)	9.70 A	15.0 A			
Max inrush (0-pk) 120V input	1.15 A	1.15 A			
Nom (rms) 120/240V input	5.0 A	8.6 A	5.0 A	8.6 A	15.0 A
Max inrush (0-pk) 240V input	1.1 A	1.1 A	136 A	2.3 A	2.3 A
Current loop update rate	125 µs				
Command update rate					
Velocity loop	500 µs				
Position loop	500 µs				
Integrated AC line filter	No	No	Yes	Yes	Yes
Control power back-up input voltage	20…26V DC				
Control power back-up input current					
Nom	500 mA				
Max inrush (0-pk)	30 A				
Continuous output current (rms)	2.0 A	4.0 A	2.0 A	4.0 A	8.0 A
Continuous output current (0-pk)	2.8 A	5.7 A	2.8 A	5.7 A	11.3 A
Peak output current (rms) (2)	6.0 A	12.0 A	6.0 A	12.0 A	24.0 A
Peak output current (0-pk)	8.5 A	17.0 A	8.5 A	17.0 A	39.9 A
Continuous power output (3) @ 240V nom or 120V (Voltage-doubler mode)	0.40 kW (4)	0.80 kW (4)	0.40 kW	0.80 kW	1.70 kW
Shunt On (5)	390V DC				
Shunt Off (5)	375V DC				
Overvoltage	430V DC				
Short circuit current rating	100,000 A (rms) symmetrical				

(1) Kinetix 350 drive modules are limited to 1 AC mains power cycling per every 2 minutes.
(2) Peak RMS current allowed for up to 2 seconds with a 50% duty cycle.
(3) Nominal continuous power output (kW) applies to 240V AC drives. Value is approximately one-half of this kW rating when using 120V AC.
(4) The 120V voltage-doubler mode applies to only the 2097-V31PR*x*-LM drives.
(5) The drive has an internal shunt transistor.

Table 57 - Kinetix 350 Drive (single-phase and three-phase) Power Specifications

Attribute	2097-V33PR1-LM	2097-V33PR3-LM	2097-V33PR5-LM	2097-V33PR6-LM
AC input voltage	80…132V rms single-phase (120V nom) 80…264V rms single-phase (240V nom) 80…264V rms three-phase (240V nom)			
AC input frequency	48…62 Hz			
Main AC input current (1)				
Nom (rms) 120V input	5.0 A	8.6 A	15.0 A	24.0 A
Max inrush (0-pk) 120V input	68.0 A	1.15 A	1.15 A	5.65 A
Nom (rms) 240V input	3.0A	5.0A	8.7A	13.9 A
Max inrush (0-pk) 240V input	136 A	2.3 A	2.3 A	11.3 A
Current loop update rate	125 µs			
Command update rate				
Velocity loop	500 µs			
Position loop	500 µs			
Integrated AC line filter	No	No	No	No
Control power back-up input voltage	20…26V DC			
Control power back-up input current				
Nom	500 mA			
Max inrush (0-pk)	30 A			
Continuous output current (rms)	2.0 A	4.0 A	8.0 A	12.0 A
Continuous output current (0-pk)	2.8 A	5.7 A	11.3 A	17.0 A
Peak output current (rms) (2)	6 A	12 A	24 A	36 A
Peak output current (0-pk)	8.5 A	17.0 A	33.9 A	50.9 A
Continuous power output (3) @ 240V nom	0.50 kW	1.00 kW	2.00 kW	3.00 kW
Shunt On (4)	390 V DC			
Shunt Off (4)	375V DC			
Overvoltage	430V DC			
Short circuit current rating	100,000 A (rms) symmetrical			

(1) Kinetix 350 drive modules are limited to 1 AC mains power cycling per every 2 minutes.

(2) Peak RMS current allowed for up to 2 seconds with a 50% duty cycle.

(3) Nominal continuous power output (kW) applies to 240V AC drives. Value is approximately one-half of this kW rating when using 120V AC.

(4) The drive has an internal shunt transistor.

Table 58 - Kinetix 350 Drive (three-phase) Power Specifications

Attribute	2097-V34PR3-LM	2097-V34PR5-LM	2097-V34PR6-LM
AC input voltage	320…528V rms three-phase (480V nom)		
AC input frequency	48…62 Hz		
Main AC input current [1] Nom (rms) Max inrush (0-pk)	 2.7A 4.5 A	 5.5 A 4.5 A	 7.9 A 22.6 A
Current loop update rate	125 µs		
Command update rate Velocity loop Position loop	 500 µs 500 µs		
Integrated AC line filter	No	No	No
Control power back-up input voltage	20…26V DC		
Control power back-up input current Nom Max inrush (0-pk)	 500 mA 30 A		
Continuous output current (rms)	2.0 A	4.0 A	6.0 A
Continuous output current (0-pk)	2.8 A	5.7 A	8.5 A
Peak output current (rms) [2]	6 A	12 A	18 A
Peak output current (0-pk)	8.5 A	17.0 A	25.5 A
Continuous power output @ 480V nom	1.00 kW	2.00 kW	3.00 kW
Shunt On [3]	780V DC		
Shunt Off [3]	750V DC		
Overvoltage	850V DC		
Short circuit current rating	100,000 A (rms) symmetrical		

(1) Kinetix 350 drive modules are limited to 1 AC mains power cycling per every 2 minutes.
(2) Peak RMS current allowed for up to 2 seconds with a 50% duty cycle.
(3) The drive has an internal shunt transistor.

Circuit Breaker/Fuse Specifications

While circuit breakers offer some convenience, there are limitations for their use. Circuit breakers do not handle high current inrush as well as fuses.

Make sure the selected components are properly coordinated and meet acceptable codes including any requirements for branch circuit protection. Evaluation of the short-circuit available current is critical and must be kept below the short-circuit current rating of the circuit breaker.

Use class CC or T fast-acting current-limiting type fuses, 200,000 AIC, preferred. Use Bussmann KTK-R, JJN, JJS or equivalent. Thermal-magnetic type breakers preferred. The following fuse examples and Allen-Bradley circuit breakers are recommended for use with Kinetix 350 drives.

Cat. No.	Drive Voltage	Main VAC		
		Bussmann Fuse	Allen-Bradley Circuit Breaker (1)	
			Disconnect (2)	Magnetic Contactor (3)
2097-V31PR0-LM	120V	KTK-R-20 (20A)	1492-SP1D200	140M-F8E-C20
	240V	KTK-R-10 (10A)	1492-SP1D100	140M-F8E-C10
2097-V31PR2-LM	120V	KTK-R-30 (30A)	1492-SP1D300	140M-F8E-C32
	240V	KTK-R-20 (20A)	1492-SP1D200	140M-F8E-C20
2097-V32PR0-LM	240V	KTK-R-20 (20A)	1492-SP3D200	140M-F8E-C20
2097-V32PR2-LM				
2097-V32PR4-LM	240V	KTK-R-30 (30A)	1492-SP3D320	140M-F8E-C32
2097-V33PR1-LM	120V	KTK-R-20 (20A)	1492-SP1D200	140M-F8E-C20
	240V	KTK-R-15 (15A)	1492-SP3D150	140M-F8E-C16
2097-V33PR3-LM	120V	KTK-R-20 (20A)	1492-SP1D200	140M-F8E-C20
	240V	KTK-R-15 (15A)	1492-SP3D150	140M-F8E-C16
2097-V33PR5-LM	120V	KTK-R-30 (30A)	1492-SP1D300	140M-F8E-C32
	240V	KTK-R-20 (20A)	1492-SP3D200	140M-F8E-C20
2097-V33PR6-LM	120V	N/A	N/A	N/A
	240V	KTK-R-30 (30A)	1492-SP3D300	140M-F8E-C32
2097-V34PR3-LM	480V	KTK-R-10 (10A)	1492-SP3D100	140M-F8E-C10
2097-V34PR5-LM		KTK-R-10 (10A)	1492-SP3D100	140M-F8E-C10
2097-V34PR6-LM		KTK-R-20 (20A)	1492-SP3D200	140M-F8E-C20

(1) When using Bulletin 1492 circuit protection devices, the maximum short circuit current available from the source is limited to 5000 A.

(2) Use fully-rated short-circuit protection circuit breaker for device branch circuit protection only when there is an upstream fully-rated breaker.

(3) Fully-rated breaker for overload current and short circuit rating.

Contactor Ratings

Table 59 - Kinetix 350 Drives (120/240V)

Cat. No.	Drive Voltage	AC Coil Contactor	DC Coil Contactor
2097-V31PR0-LM	120V	100-C23x10	100-C23Zx10
	240V	100-C12x10	100-C12Zx10
2097-V31PR2-LM	120V	100-C30x10	100-C30Zx10
	240V	100-C23x10	100-C23Zx10

Table 60 - Kinetix 350 Drives (240V)

Cat. No.	Drive Voltage	AC Coil Contactor	DC Coil Contactor
2097-V32PR0-LM	240V	100-C23x10	100-C23Zx10
2097-V32PR2-LM	240V	100-C23x10	100-C23Zx10
2097-V32PR4-LM	240V	100-C30x10	100-C30Zx10
2097-V33PR1-LM	120V	100-C23x10	100-C23Zx10
	240V	100-C16x10	100-C16Zx10
2097-V33PR3-LM	120V	100-C23x10	100-C23Zx10
	240V	100-C16x10	100-C16Zx10
2097-V33PR5-LM	120V	100-C30x10	100-C30Zx10
	240V	100-C23x10	100-C23Zx10
2097-V33PR6-LM	120V	N/A	N/A
	240V	100-C30x10	100-C30Zx10

Table 61 - Kinetix 350 Drives (480V)

Cat. No.	Drive Voltage	AC Coil Contactor	DC Coil Contactor
2097-V34PR3-LM	480V	100-C12x10	100-C12Zx10
2097-V34PR5-LM		100-C12x10	100-C12Zx10
2097-V34PR6-LM		100-C23x10	100-C23Zx10

Transformer Specifications for Input Power

Attribute	Value (460V system)
Input volt-amperes	750VA
Input voltage	480V AC
Output voltage	120…240V AC

Power Dissipation Specifications

This table shows the maximum power dissipation of each drive. Use this table to size an enclosure and calculate required ventilation for your Kinetix 350 drive system.

Cat. No.	Power Dissipation, W
2097-V31PR0-LM	28
2097-V31PR2-LM	39
2097-V32PR0-LM	28
2097-V32PR2-LM	39
2097-V32PR4-LM	67
2097-V33PR1-LM	28
2097-V33PR3-LM	39
2097-V33PR5-LM	67
2097-V33PR6-LM	117
2097-V34PR3-LM	39
2097-V34PR5-LM	58
2097-V34PR6-LM	99

General Specifications

This section contains general specifications for your Kinetix 350 drive system components.

Environmental Specifications

Attribute	Operating Range	Storage Range (nonoperating)
Ambient temperature	0…40 °C (32…104 °F)	-10…70 °C (14…158 °F)
Relative humidity	5…95% noncondensing	5…95% noncondensing
Altitude	De-rate by 1% per 300 m (1000 ft) above 1500 m (5000 ft)	3000 m (9843 ft) during transport
Vibration	5…2000 Hz @ 2.5 g peak, 0.015 mm (0.0006 in.) max displacement	
Shock	15 g, 11 ms half-sine pulse (3 pulses in each direction of 3 mutually perpendicular directions)	

Maximum Feedback Cable Lengths

Although Bulletin 2090 motor feedback cables are available in standard lengths up to 90 m (295.3 ft), the maximum feedback cable length for connecting motors or actuators to Kinetix 350 drives is 20 m (65.6 ft).

IMPORTANT System performance was tested at these cable length specifications These limitations are also a CE requirement.

Weight Specifications

Kinetix 350 Drive Cat. No.	Value, approx. kg (lb)
2097-V31PR0-LM	1.3 (2.86)
2097-V31PR2-LM	1.5 (3.31)
2097-V32PR0-LM	1.4 (3.09)
2097-V32PR2-LM	1.7 (3.75)
2097-V32PR4-LM	2.2 (4.85)
2097-V33PR1-LM	1.3 (2.86)
2097-V33PR3-LM	1.5 (3.31)
2097-V33PR5-LM	2.0 (4.41)
2097-V33PR6-LM	1.9 (4.19)
2097-V34PR3-LM	1.5 (3.31)
2097-V34PR5-LM	2.0 (4.41)
2097-V34PR6-LM	1.8 (3.97)

Certifications

Certification (1) (when product is marked)	Standards
c-UL-us	UL Listed to U.S. and Canadian safety standards (UL 508 C File E59272).
	Solid-state motor overload protection provides dynamic fold-back of motor current when 110% of the motor rating is reached with a peak current limit based on the peak rating of the motor as investigated by UL to comply with UL 508C (UL File E59272, volume 1, section 22).
CE	European Union 2004/108/EC EMC Directive compliant with EN 61800-3:2004: Adjustable Speed Electrical Power Drive Systems - Part 3; EMC Product Standard including specific test methods. European Union 2006/95/EC Low Voltage Directive compliant with: • EN 61800-5-1:2003 - Safety of Machinery - Electrical Equipment of Machines. • EN 50178:1997 - Electronic Equipment for use in Power Installations.
Functional Safety	• EN 61800-5-2:2007 - Adjustable speed electrical power drive systems • EN 62061:2005 - Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems • EN ISO 13849-1:2008 - Safety of machinery - Safety-related parts of control systems • IEC 61508:Part 1-7:2000 - Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems
C-Tick	• Radio Communications Act: 1992 • Radio Communications (Electromagnetic Compatibility) Standard: 1998 • Radio Communications (Compliance Labelling - Incidental Emissions) Notice: 1998 • AS/NZS CISPR 11: 2003 (Group 1, Class A)

(1) Refer to http://www.ab.com for Declarations of Conformity Certificates.

AC Line Filter Specifications

These tables contain specifications for AC line filters available for Kinetix 350 servo drive systems.

Table 62 - AC Line Filter Specifications (Bulletin 2090)

Attribute	2090-XXLF-TC116	2090-UXLF-336
Kinetix 350 Drive (1) Cat. No.	2097-V31PR0-LM 2097-V31PR2-LM	2097-V33PR5-LM
Voltage	250V AC 50/60 Hz	
Phase	Single	Three-phase
Current A @ 50 °C (122 °F)	16	36
Power loss W	–	–
Leakage current mA	87	136
Weight, approx. kg (lb)	0.80 (1.7)	2.7 (5.9)
Humidity	90% relative humidity	
Vibration	10…200 Hz @ 1.8 g vibration	
Operating temperature	-25…100 °C (-13…212 °F)	-25…85 °C (-13…185 °F)

(1) Kinetix 350 drives (catalog numbers 2097-V32PR0-LM, 2097-V32PR2-LM, and 2097-V32PR4-LM) have integrated AC line filters.

Table 63 - AC Line Filter Specifications (Bulletin 2097)

Attribute	2097-F1	2097-F2	2097-F4 (1)		2097-F5 (1)		2097-F6 (1)
Kinetix 350 Drive (2) Cat. No.	2097-V33PR6-LM	2097-V34PR6-LM	2097-V33PR1-LM	2097-V34PR3-LM	2097-V34PR5-LM	2097-V33PR3-LM	2097-V33PR5-LM
Voltage	120/240V AC 50/60 Hz	480V AC 50/60 Hz	120/240V AC 50/60 Hz	480V AC 50/60 Hz		120/240V AC 50/60 Hz	
Phase	Single-phase	Three-phase	Single or Three-phase	Three-phase		Single or Three-phase	Single-phase
Current A @ 40 °C (104 °F)	24	10	4.4		6.9		15.0
Power loss W	5.2	2.8	1.2		1.3		4.1
Leakage current mA	9	1					
Weight, approx. kg (lb)	0.6 (1.3)		0.8 (1.8)				
Humidity	5…95% noncondensing						
Vibration	5…2000 Hz @ 2.5 g peak, 0.015 mm (.0006 in.) maximum displacement						
Operating temperature	0…40 °C (32…104 °F)						

(1) This filter is rated for multiple voltage/phase line conditions.

(2) Kinetix 350 drives (catalog numbers 2097-V32PR0-LM, 2097-V32PR2-LM, and 2097-V32PR4-LM) have integrated AC line filters.

Shunt Resistor Specifications

Bulletin 2097 passive shunt resistor wire to the Kinetix 350 drive.

Table 64 - Shunt Resistor Power Specifications

Attribute	2097-R2	2097-R3	2097-R4	2097-R6	2097-R7
Use with Kinetix 350 drive Cat. No.	2097-V32PR4-LM 2097-V33PR5-LM	2097-V33PR6-LM	2097-V31PR0-LM 2097-V31PR2-LM 2097-V32PR0-LM 2097-V32PR2-LM 2097-V33PR1-LM 2097-V33PR3-LM	2097-V34PR5-LM 2097-V34PR6-LM	2097-V34PR3-LM
Resistor value Ω	20	30	40	75	150
Peak power kW	7.6	5.1	3.8	7.9	4.0
Peak current A	19.5	13.0	9.8	10.3	5.1
Continuous power W	150		80	150	80
% RD_Application, max (1)	1.97	2.96	2.10	1.90	2.02
Weight, approx. kg (lb)	0.3 (0.7)		0.2 (0.4)	0.3 (0.7)	0.2 (0.4)

(1) RD_Application is the application duty cycle in percent. For the intermittent regeneration applications use RD_Application = t/T. Where t is the duration when regeneration is needed and T is the time interval between two regenerations. Both t and T must use the same time units such as seconds.

Product Dimensions

This section contains product dimensions for your Kinetix 350 servo drives.

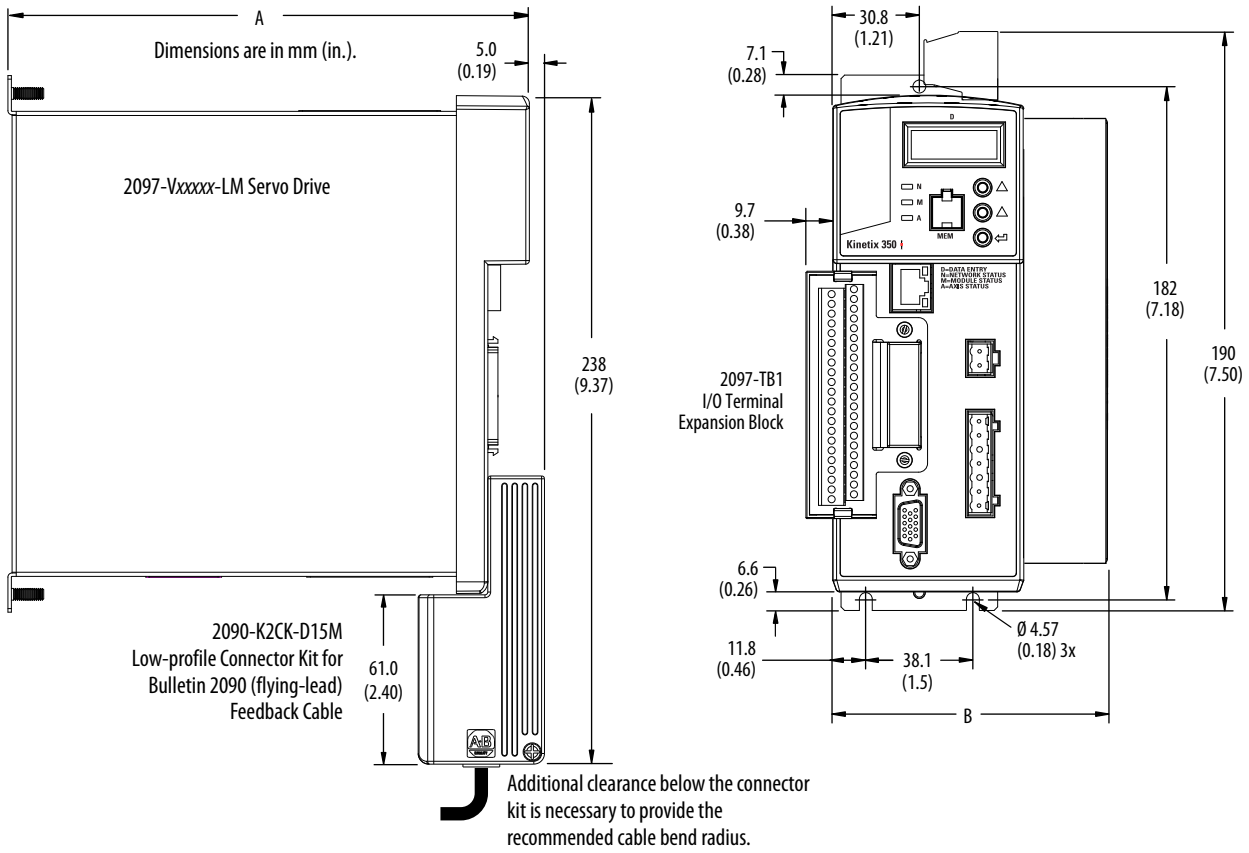


Table 65 - Kinetix 350 Dimensions

Cat. No.	A mm (in.)	B mm (in.)
2097-V31PR0-LM	185 (7.29)	68.0 (2.68)
2097-V31PR2-LM	185 (7.29)	69.0 (2.70)
2097-V32PR0-LM	230 (9.04)	68.0 (2.68)
2097-V32PR2-LM	230 (9.04)	69.0 (2.70)
2097-V32PR4-LM	230 (9.04)	87.0 (3.42)
2097-V33PR1-LM	185 (7.29)	68.0 (2.68)

Cat. No.	A mm (in.)	B mm (in.)
2097-V33PR3-LM	185 (7.29)	69.0 (2.70)
2097-V33PR5-LM	185 (7.29)	94.0 (3.72)
2097-V33PR6-LM	230 (9.04)	68.0 (2.68)
2097-V34PR3-LM	185 (7.29)	69.0 (2.70)
2097-V34PR5-LM	185 (7.29)	94.0 (3.72)
2097-V34PR6-LM	230 (9.04)	68.0 (2.68)

Notes:

Interconnect Diagrams

Introduction

This appendix provides wiring examples and system block diagrams for your Kinetix 350 drive system components.

Interconnect Diagram Notes

This appendix provides wiring examples to assist you in wiring the Kinetix 350 system. The notes below apply to the wiring examples on the pages that follow.

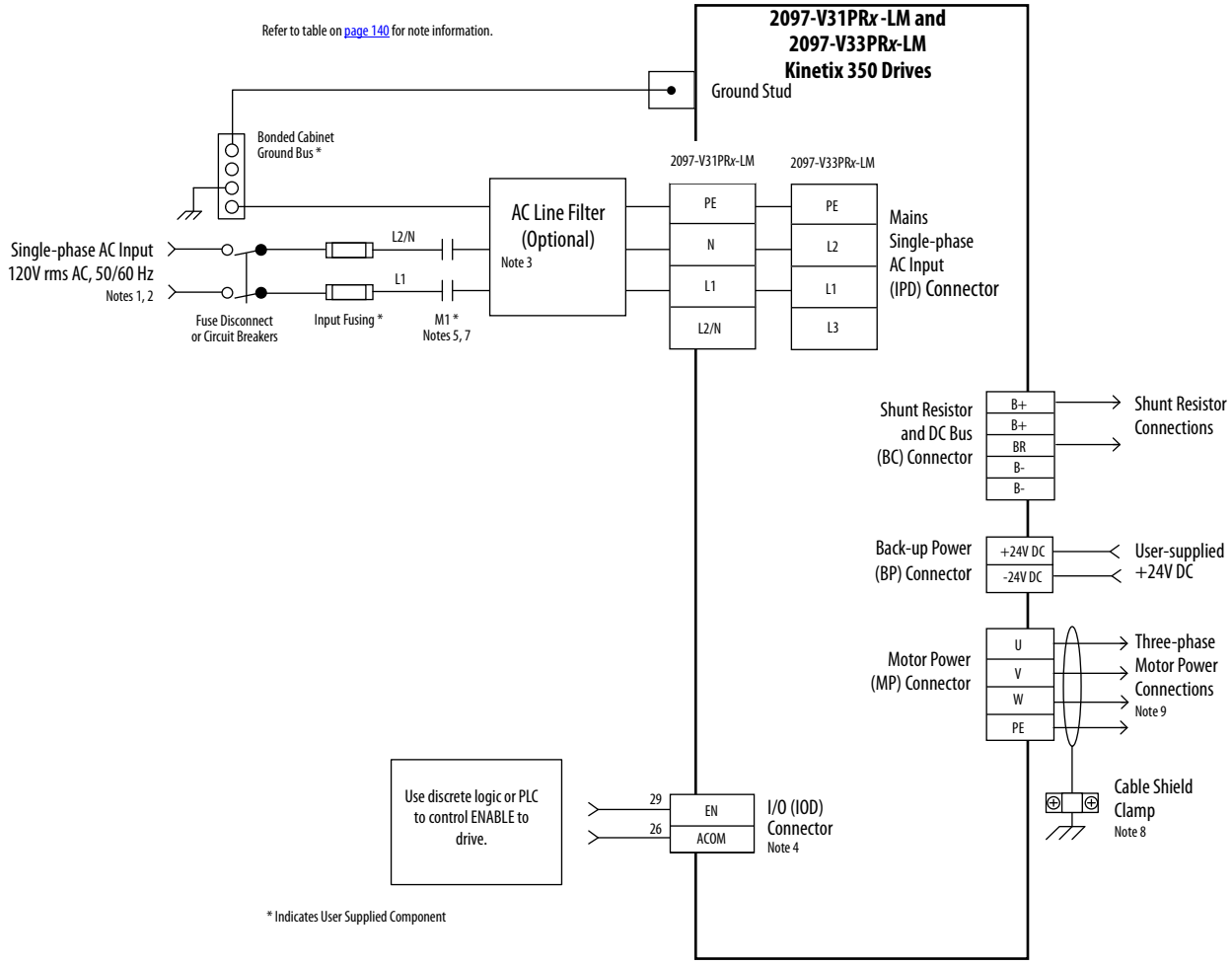
Note	Information
1	For power wiring specifications, refer to Power Wiring Requirements on page 55.
2	For input fuse and circuit breaker sizes, refer to Circuit Breaker/Fuse Specifications on page 131.
3	Place the AC (EMC) line filters as close to the drive as possible and do not route very dirty wires in the wireway. If routing in wireway is unavoidable, use shielded cable with shields grounded to the drive chassis and filter case. For AC line filter specifications, refer to AC Line Filter Specifications on page 135. This filter does not apply to 2097-V32PR*x*-LM drives because they have integrated AC line filters.
4	Terminal block is required to make connections.
5	Contactor coil (M1) needs integrated surge suppressors for AC coil operation. Refer to Contactor Ratings on page 132.
6	Refer to the Motor Brake Currents table on page 149 to size the interposing relay for your application and for a detailed schematic of brake implementation.
7	Drive Enable input must be opened when main power is removed, or a drive fault occurs. A delay of at least 1.0 second must be observed before attempting to enable the drive after main power is restored.
8	Cable shield clamp must be used to meet CE requirements. No external connection to ground is required.
9	For motor cable specifications, refer to the Kinetix Motion Control Selection Guide, publication GMC-SG001.
10	Motor power cables (catalog numbers 2090-XXNPMF-*xx*S*xx* and 2090-CPBM6DF-16AA*xx*) have a drain wire that must be folded back under the cable shield clamp.
11	MPL-A*xxx*, MPM-A*xxx*, MPF-A*xxx*, MPS-A*xxx*, MPAR-A*xxx*, MPAI-A*xxx*, and MPAS-A*xxx*, encoders use the +5V DC supply. MPL-B*xxx*, MPM-B*xxx*, MPF-B*xxx*, MPS-B*xxx*, MPAR-B*xxx*, MPAI-B*xxx*, and MPAS-B*xxx*, encoders use +9V DC.
12	Brake connector pins are labeled plus (+) and minus (-) or F and G respectively. Power connector pins are labeled U, V, W, and GND or A, B, C, and D respectively.

Power Wiring Examples

You must supply input power components. The single-phase and three-phase line filters are wired downstream of fusing and the M1 contactor.

In this example, the 2097-V31PR*x*-LM drives are wired to use the voltage doubling circuit. The 120V input voltage provides 240V output to motors. The 2097-V33PR*x*-LM drives are wired for single-phase 120V operation.

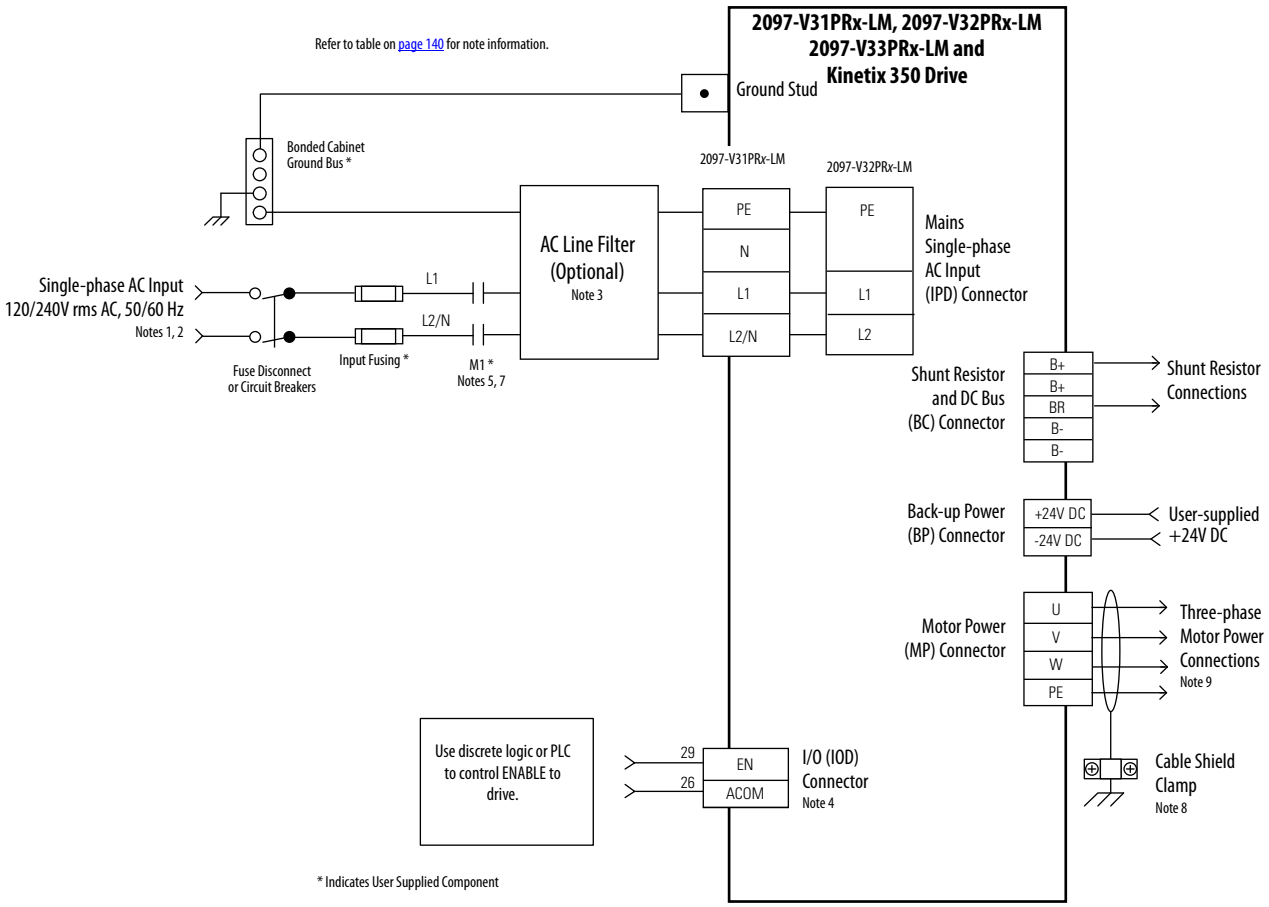
Figure 52 - Kinetix 350 Drive (120V single-phase input power)



In this example, single-phase 240V AC is applied to 2097-V31PRx-LM and 2097-V32PRx-LM drives.

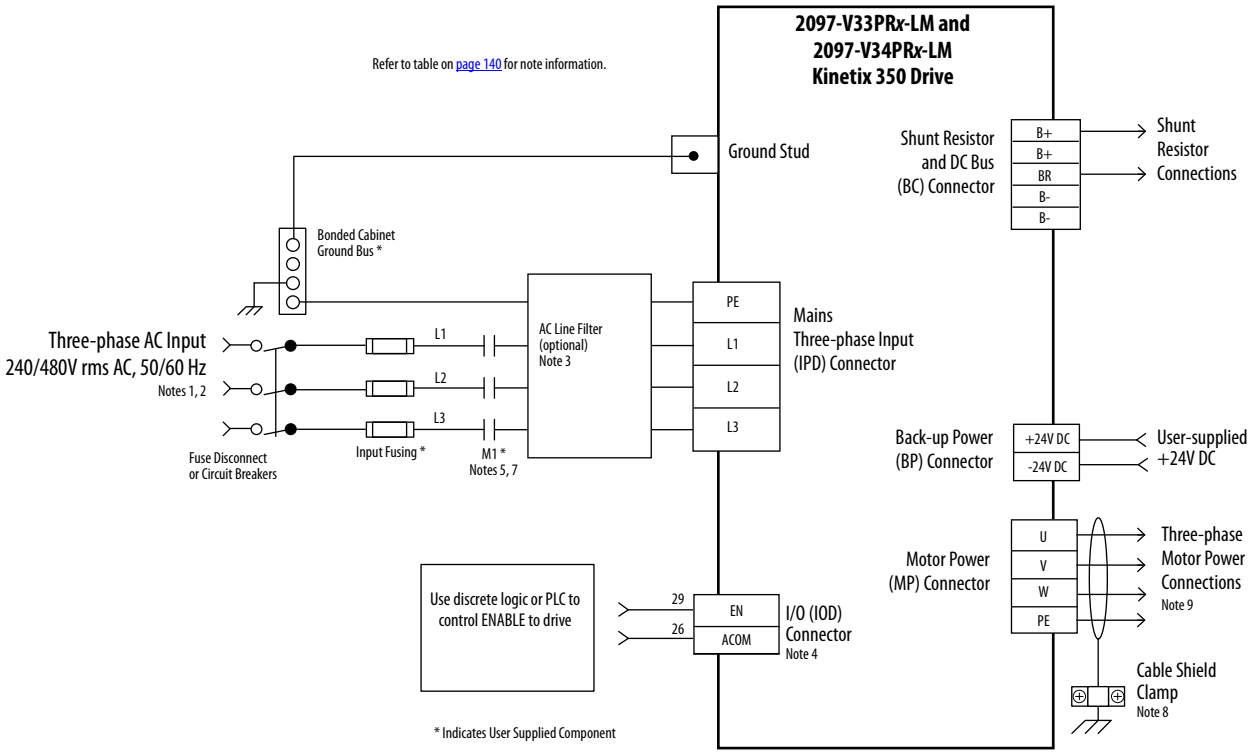
IMPORTANT The 2097-V32PRx-LM models have integrated AC line filters and do not require the AC line filter shown in this diagram.

Figure 53 - Kinetix 350 Drives (240V single-phase input power)



In this example, three-phase 240V AC is applied to 2097-V33PR*x*-LM drives and 480V AC is applied to 2097-V34PR*x*-LM drives.

Figure 54 - Kinetix 350 Drive (240/480V three-phase input power)

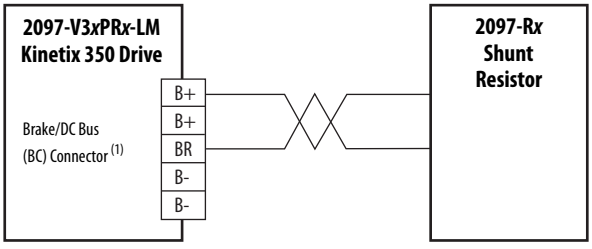


IMPORTANT For the 480V Kinetix 350 drives to meet ISO 13849-1 (PLd) spacing requirements, each phase voltage to ground must be less than or equal to 300V AC rms. This means that the power system must use center grounded wye secondary configuration for 400/480V AC mains.

Shunt Resistor Wiring Example

Refer to the Shunt Resistor Specifications on page 136, for the Bulletin 2097-R*x* shunt resistors available for the Kinetix 350 drives. Refer to the Shunt Resistor Installation Instructions, publication 2097-IN002, for additional installation information.

Figure 55 - Shunt Resistor Wiring Example



(1) This connector is for the Shunt resistor not the motor brake.

Kinetix 350 Drive/Rotary Motor Wiring Examples

These wiring diagrams apply to Kinetix 350 drives with compatible rotary motors.

Figure 56 - MP-Series (Bulletin MPL, MPM, MPF, and MPS) Motors

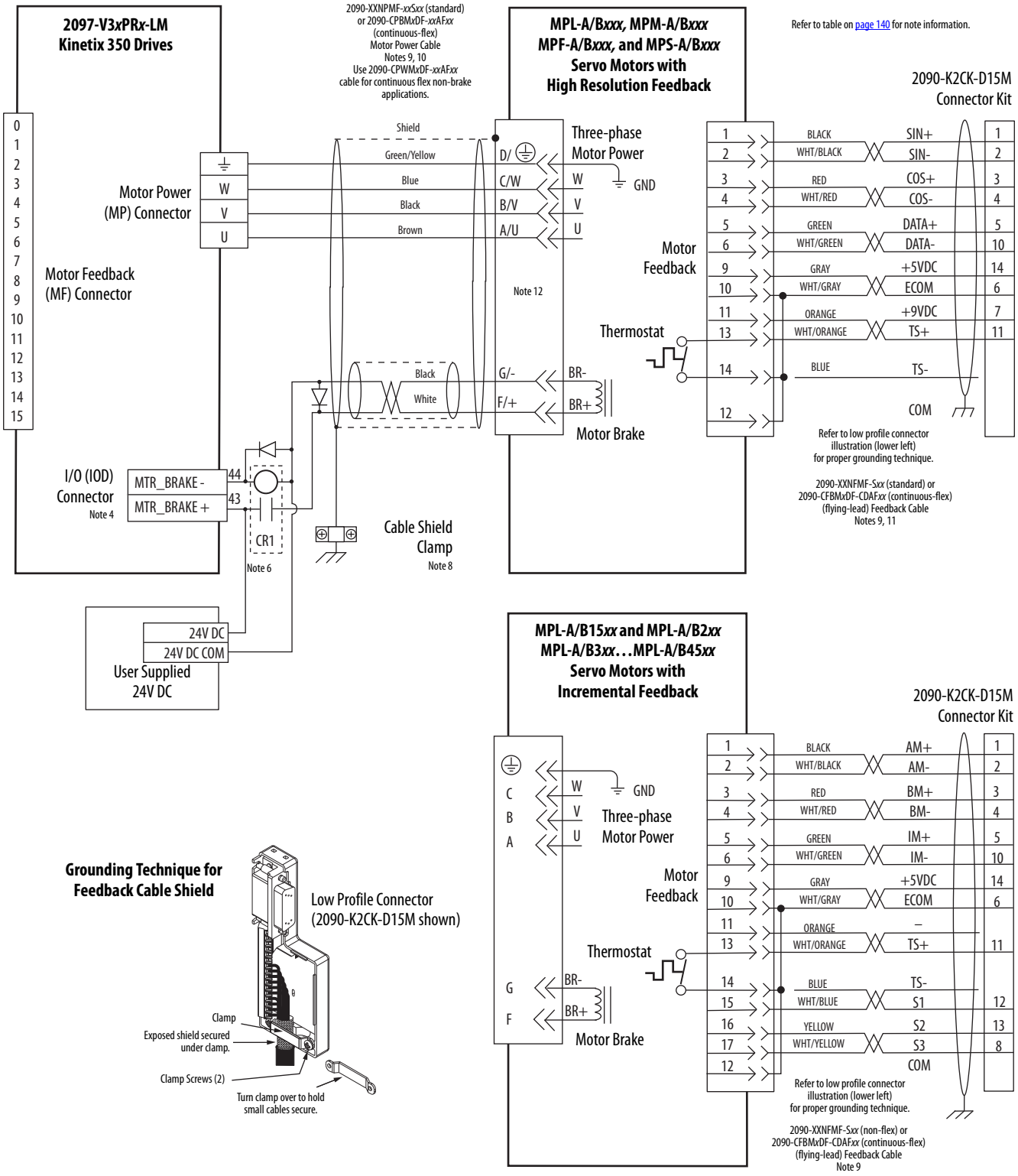
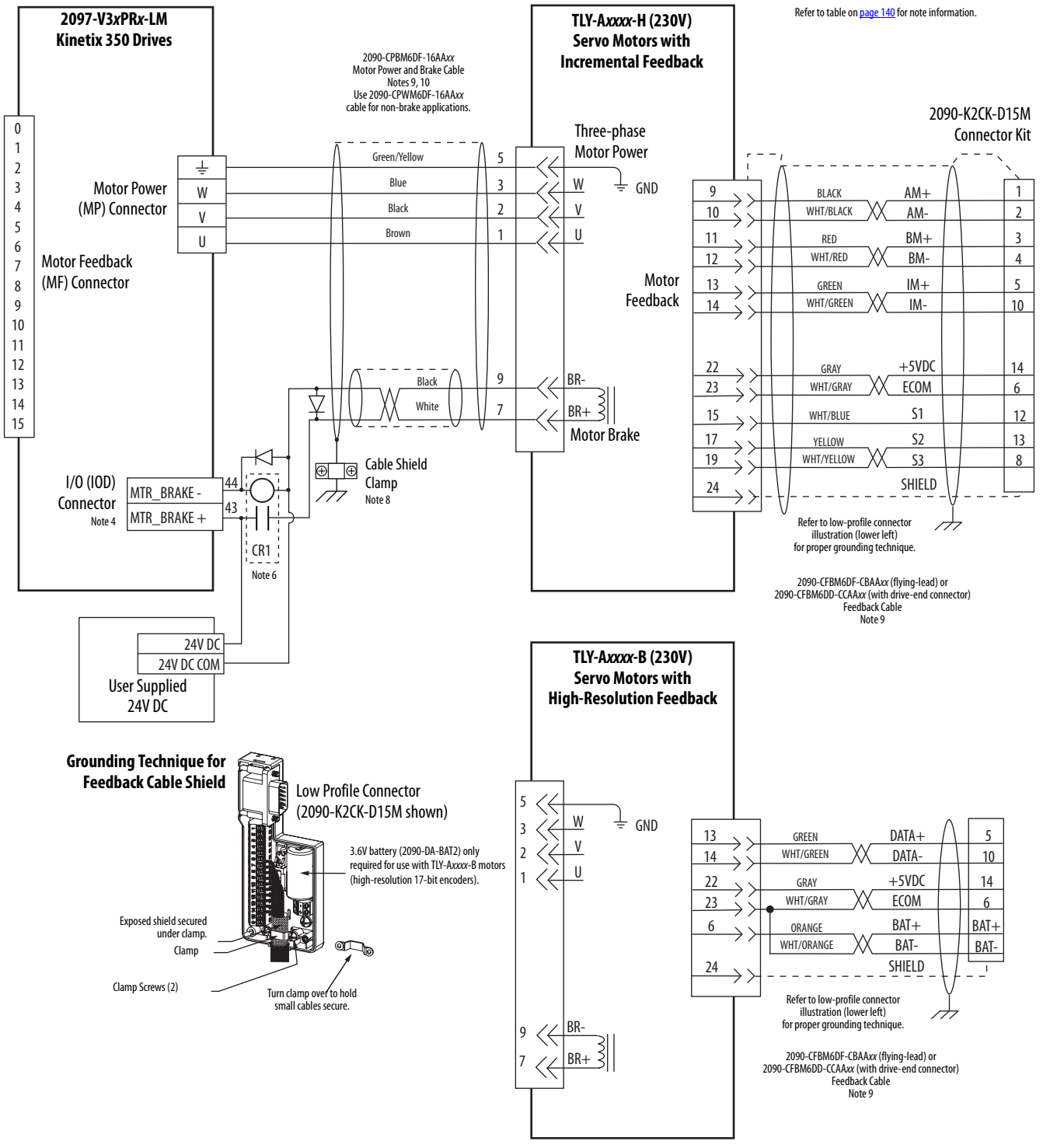


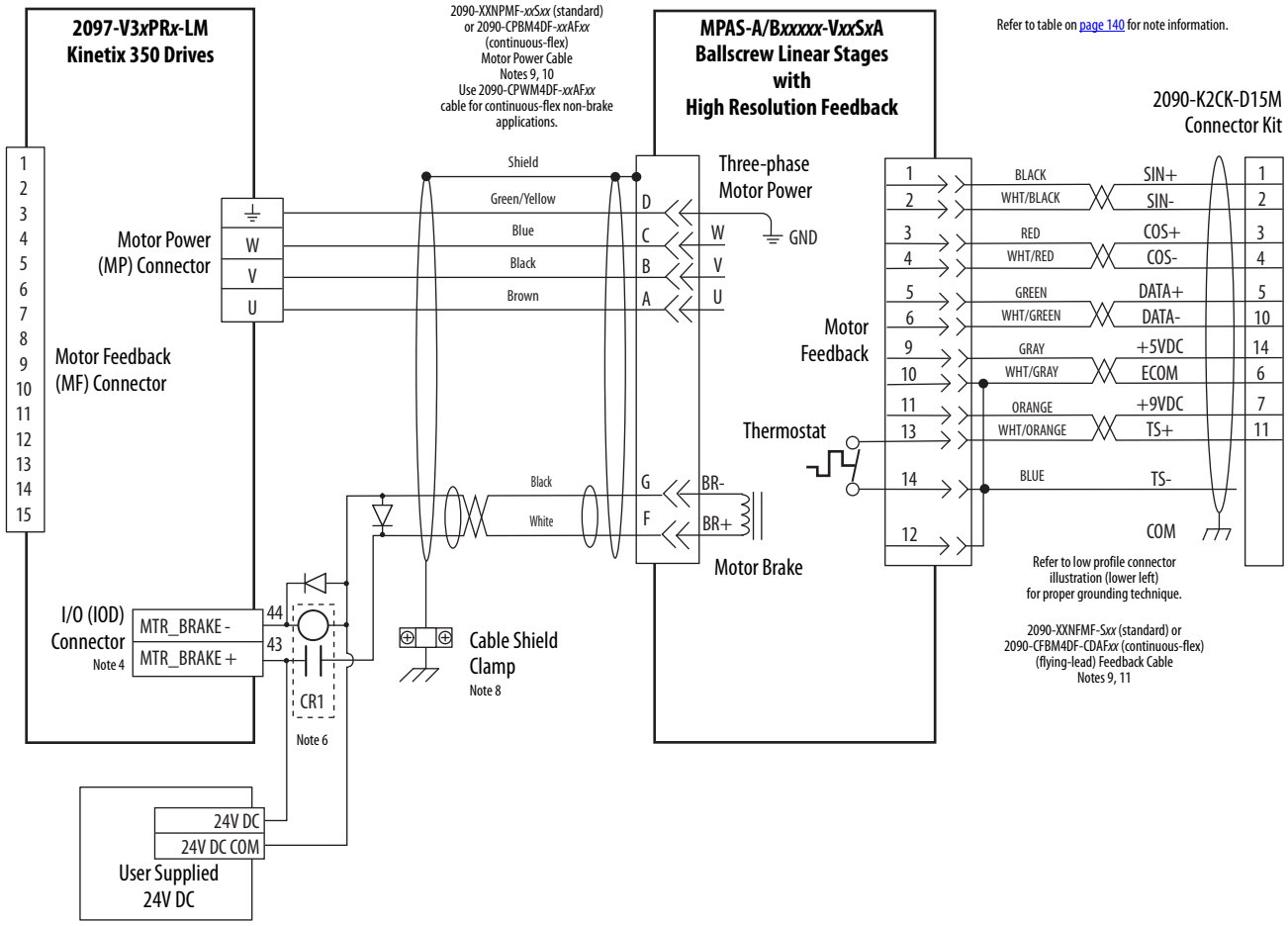
Figure 57 - Kinetix 350 Drive with TL-Series (TLY-A) Motors



Kinetix 350 Drive/Actuator Wiring Examples

These wiring diagrams apply to Kinetix 350 drives with compatible linear actuators.

Figure 58 - Kinetix 350 Drive with MP-Series (Bulletin MPAS-A/B) Linear Stages



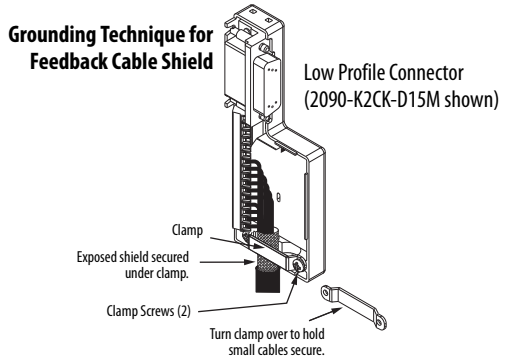
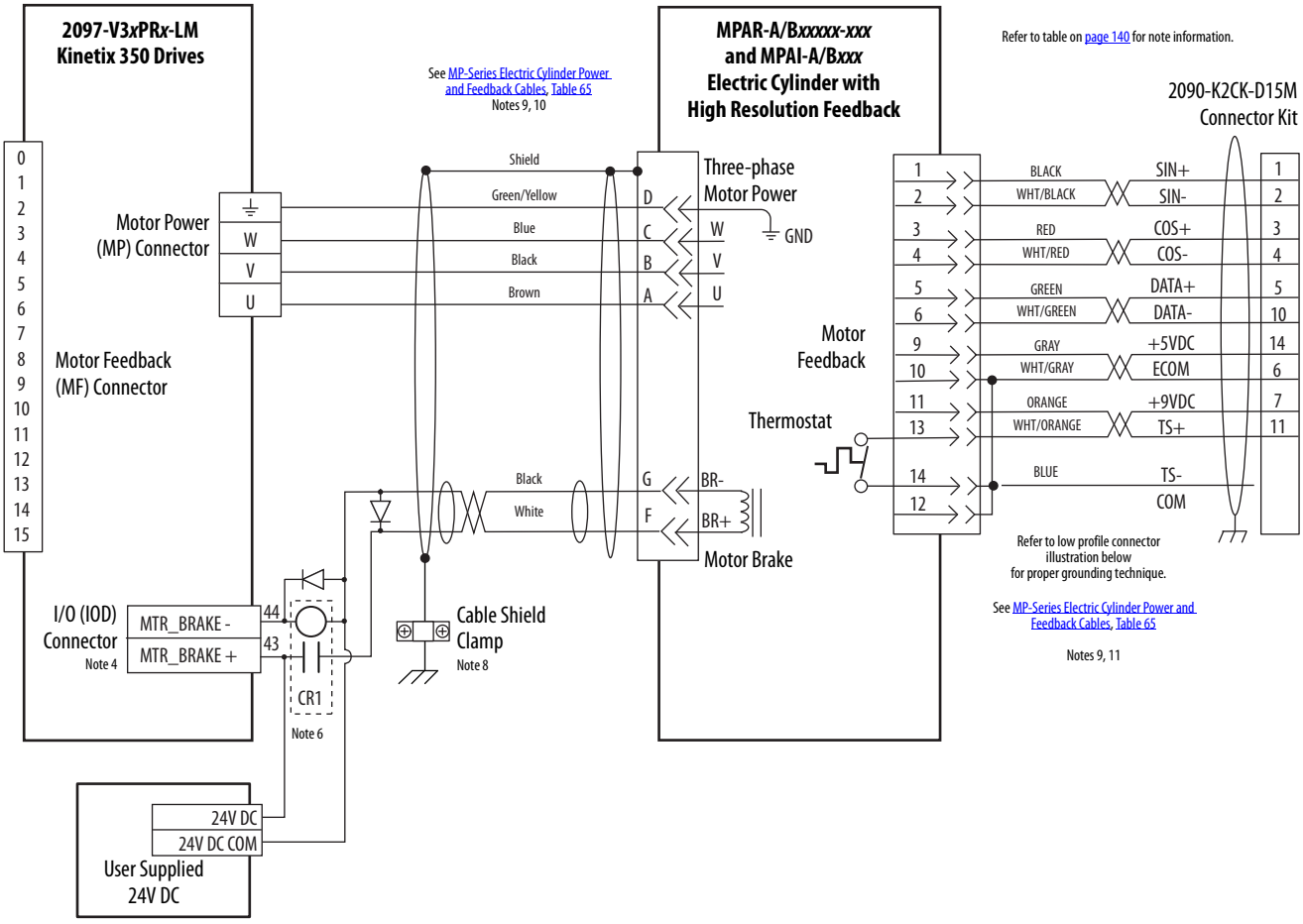


Figure 59 - Kinetix 350 Drive with MP-Series (Bulletin MPAR and MPAI) Electric Cylinders



Grounding Technique for Feedback Cable Shield

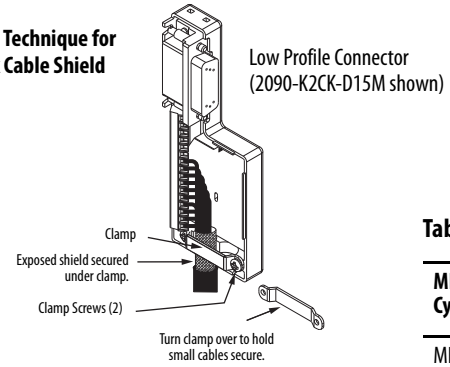
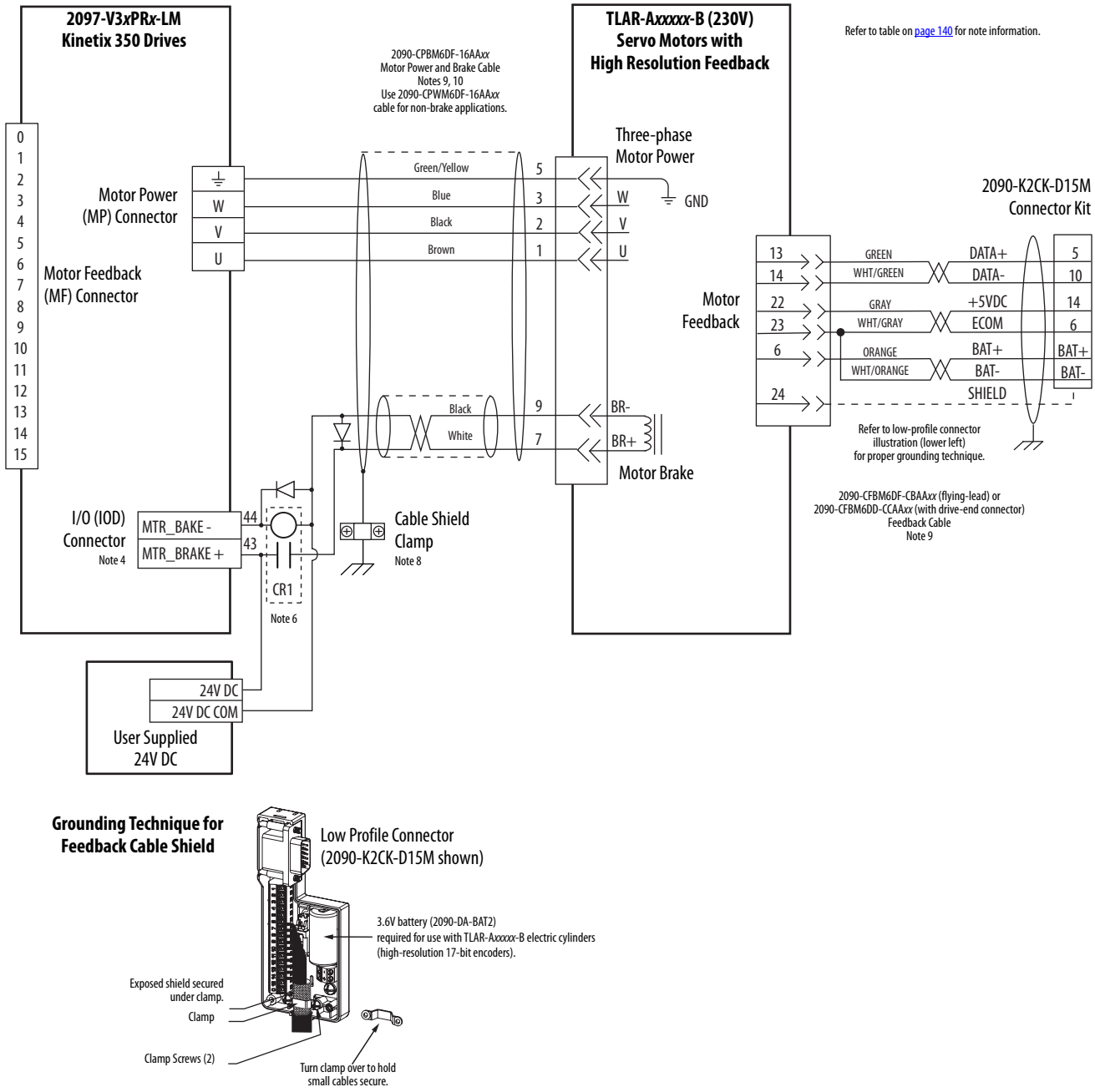


Table 65 - MP-Series Electric Cylinder Power and Feedback Cables

MP-Series Electric Cylinder Cat. No.	Frame	Power Cable Cat. No.	Feedback Cable Cat. No.
MPAR-A/B1*xxx*	32	2090-XXNPMF-16Sxx (standard) 2090-CP*x*M4DF-16AF*xx* (continuous-flex)	2090-XXNFMF-S*xx* (standard) 2090-CFBM4DF-CDAF*xx* (continuous-flex)
MPAR-A/B2*xxx*	40		
MPAR-A/B3*xxx*	63	2090-CP*x*M7DF-16AAxx (standard) 2090-CP*x*M7DF-16AF*xx* (continuous-flex)	2090-CFBM7DF-16AA*xx* (standard) 2090-CFBM7DF-CEAA*xx* (continuous-flex)
MPAI-A/B*xxx*	83		
	110		

Figure 60 - Kinetix 350 Drive with TL-Series (Bulletin TLAR) Electric Cylinders



Motor Brake Currents

Use these coil current values to size the interposing relay required for your application. Refer to the interconnect diagram for your Kinetix 350 drive/motor beginning on page 144 for typical motor brake circuitry.

Table 66 - Motor Brake Coil Currents

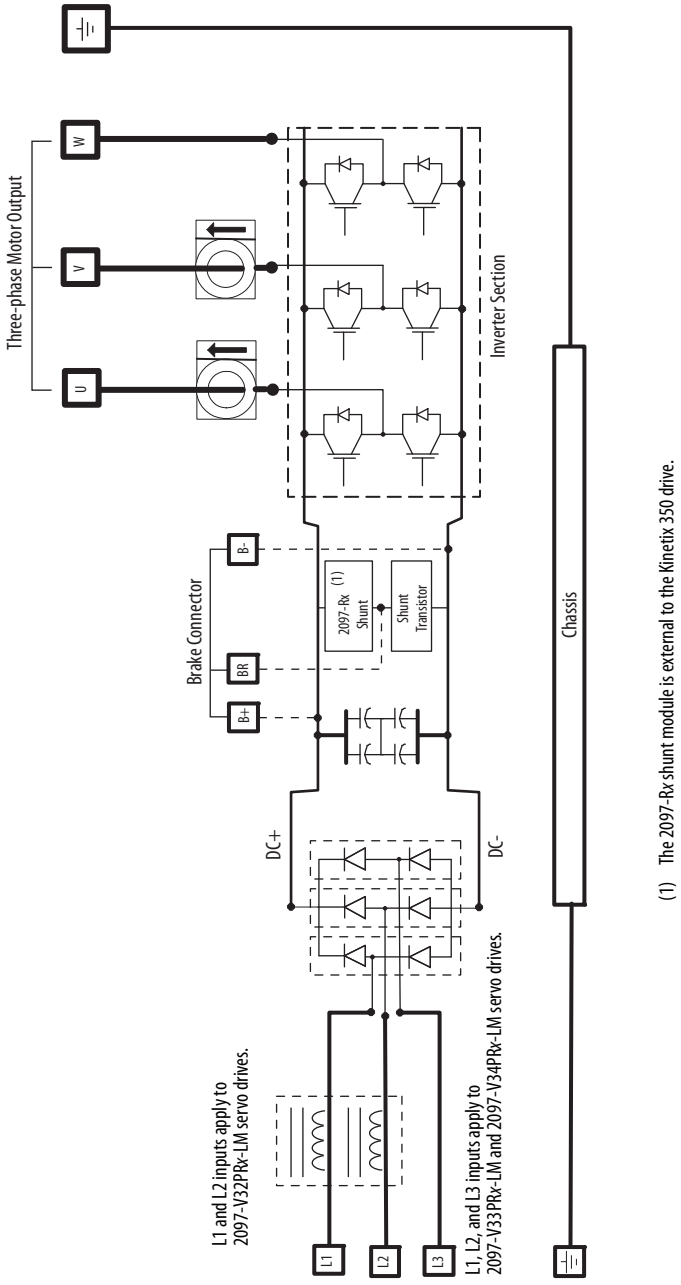
Compatible Brake Motors/Actuators (1)	Coil Current
MPL-*x*1510, MPL-*x*1520, MPL-*x*1530	0.43…0.53 A
MPL-*x*210, MPL-*x*220, MPL-*x*230	0.46…0.56 A
MPL/MPF-*x*310, MPL/MPF-*x*320, MPL/MPF-*x*330	0.45…0.55 A
MPM-*x*115	
MPS-*x*330	
MPL-*x*420, MPL-*x*430, MPL-*x*4520, MPL-*x*4530, MPL-*x*4540, MPL-B4560	0.576…0.704 A
MPM-*x*130	
MPF-*x*430, MPF-*x*4530, MPF-*x*4540	
MPS-*x*4540	
TLY-A110T, TLY-A120T, and TLY-A130T	0.18…0.22 A
TLY-A220T and TLY-A230T	0.333…0.407 A
TLY-A2530P, TLY-A2540P, and TLY-A310M	0.351…0.429 A

(1) Use of the variable x indicates this specification applies to 230V and 460V motors.

System Block Diagrams

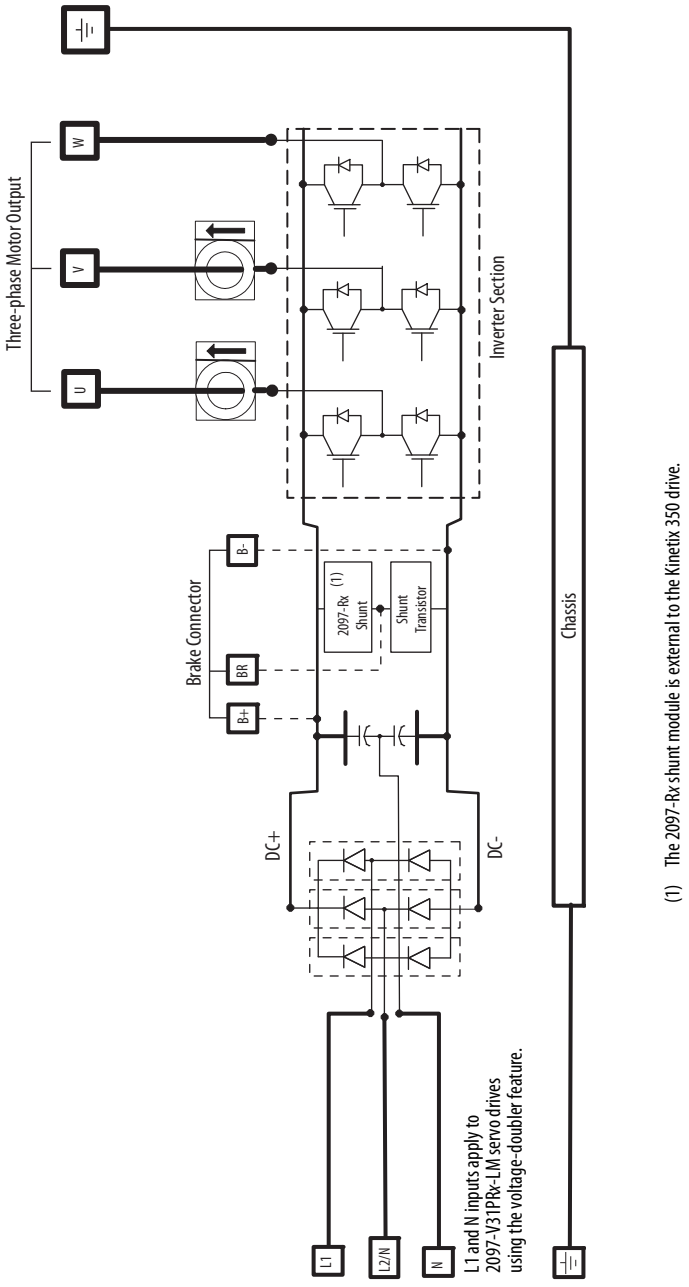
This power block diagram applies to 2097-V32PR*x*-LM, 2097-V33PR*x*-LM, and 2097-V34PR*x*-LM, servo drives.

Figure 61 - Power Block Diagram



This power block diagram applies to 2097-V31PR*x*-LM, servo drives. The voltage-doubler circuitry lets the drives with 120V input power get full performance from 240V motors.

Figure 62 - Voltage Doubler Block Diagram



Notes:

Upgrade the Kinetix 350 Drive Firmware

Introduction

This appendix provides procedures for upgrading firmware by using ControlFLASH™ software.

Upgrade Drive Firmware with ControlFLASH Software

Upgrading axis module firmware by using ControlFLASH software involves configuring your Logix communication, selecting the drive to upgrade, and upgrading the firmware.

Before You Begin

You need the following software and information before you begin.

Table 67 - Kinetix 350 System Requirements

Description	Cat. No.	Firmware Revision
RSLogix 5000 software	9324-RLD300NE	20.*x* or later
RSLinx® software		2.58 or later
ControlFLASH firmware upgrade kit(1)		8.00.017 or later
Catalog numbers of the targeted Kinetix 350 drive you want to upgrade.		
Network path to the targeted Kinetix 350 drive module you want to upgrade.		

(1) Download the ControlFLASH kit from http://support.rockwellautomation.com/controlflash. Contact Rockwell Automation Technical Support at (440) 646-5800 for assistance.

For more ControlFLASH information (not drive specific), refer to the ControlFLASH Firmware Upgrade Kit Quick Start, publication 1756-QS105.

IMPORTANT Input power or back-up power must be present at IPD or BP connector prior to upgrading your target drive.

ATTENTION: To avoid personal injury or damage to equipment during the firmware upgrade due to unpredictable motor activity, do not apply three-phase AC.

Configure Logix Communication

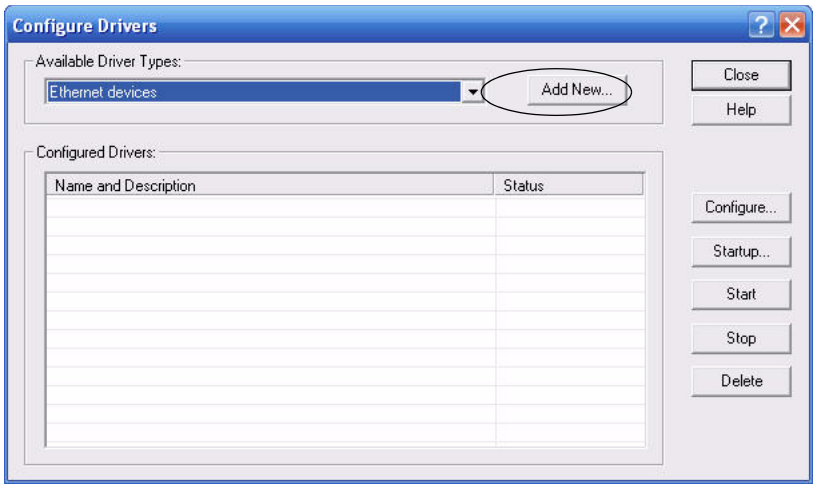
This procedure assumes that your communication method to the Logix controller is using the Ethernet protocol. It is also assumed that your Logix Ethernet module has already been configured.

For more information, refer to the ControlLogix System User Manual, publication 1756-UM001.

Follow these steps to configure Logix communication.

1. Open your RSLinx Classic software.
2. From the Communications pull-down menu, choose Configure Drivers.

   The Configure Drivers dialog box opens.



3. From the Available Drive Types pull-down menu, choose Ethernet devices.
4. Click Add New.

   The Add New RSLinx Classic Driver dialog box opens.

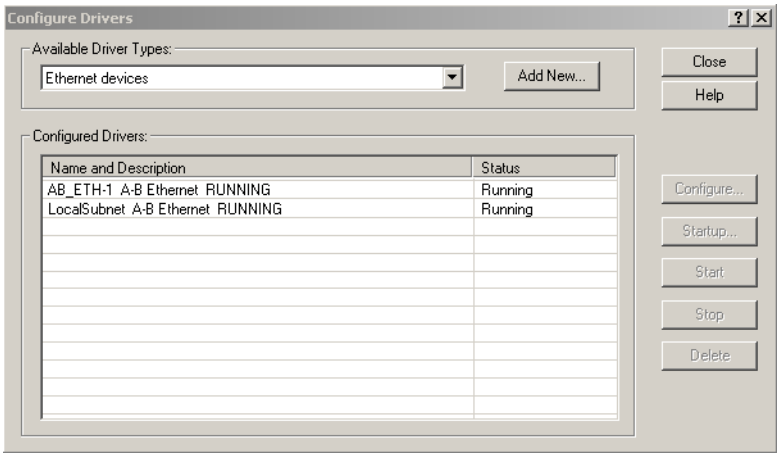
5. Type the new driver name.

6. Click OK.

   The Configure driver dialog box opens.

7. Type the IP address of your drive.
8. Click OK.

   The new Ethernet driver appears under Configured Drivers.



9. Click Close.
10. Minimize the RSLinx application dialog box.

Upgrade Firmware

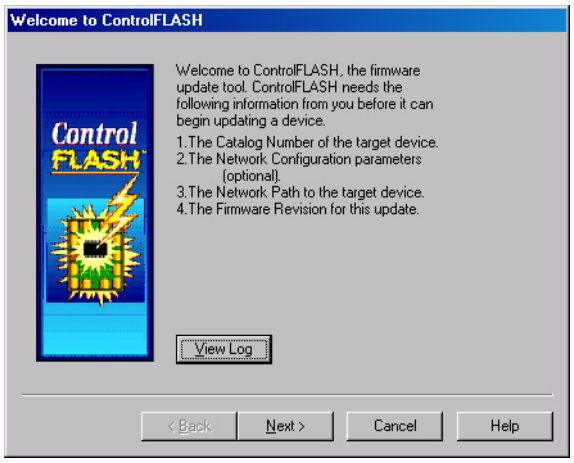
Follow these steps to select the drive module to upgrade.

1. Open your ControlFLASH software.

   You can access the ControlFLASH software by either of these methods:

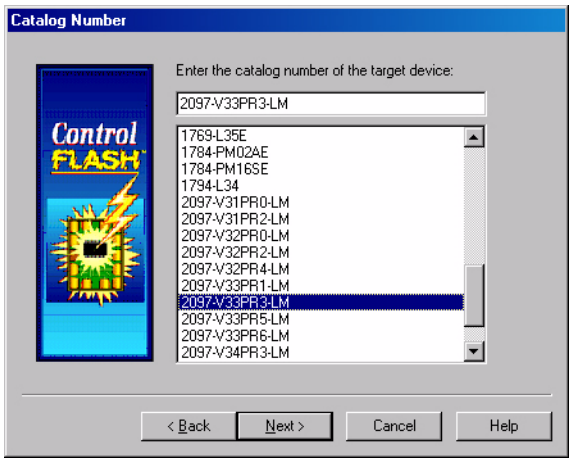
   - In RSLogix 5000 software from the Tools menu, choose ControlFLASH.
   - Choose Start>Programs>FLASH Programming Tools> ControlFLASH.

   The Welcome to ControlFLASH dialog box opens.



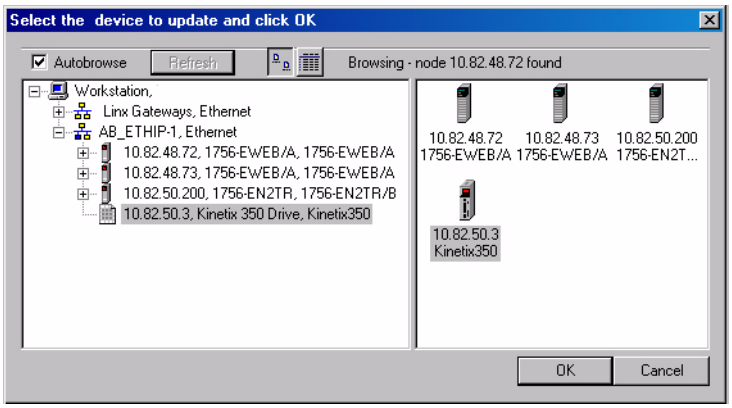
2. Click Next.

   The Catalog Number dialog box opens.



3. Select your drive module and click Next.

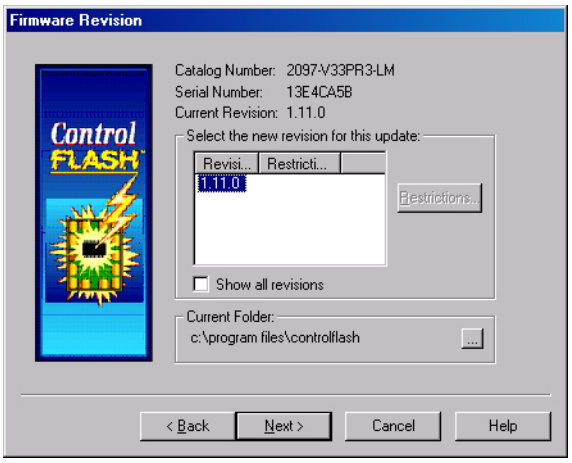
   The Select Device to Update dialog box opens.



4. Expand your Ethernet node, Logix backplane, and EtherNet/IP network module.

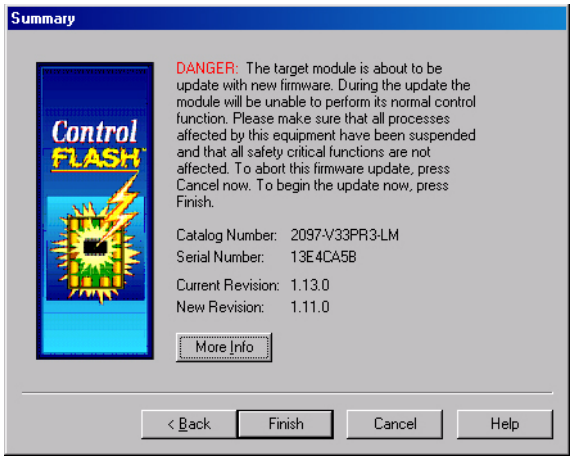
5. Select the servo drive to upgrade and click OK.

   The Firmware Revision dialog box opens.



6. Select the firmware revision to upgrade and click Next.

   The Summary dialog box opens.

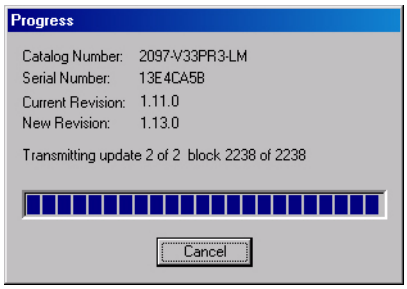


7. Confirm the drive catalog number and firmware revision and click Finish

   This ControlFLASH warning dialog box opens.

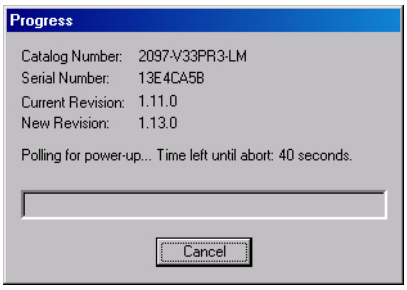
8. Click Yes (only if you are ready).

   The Progress dialog box opens and upgrading begins.



   The drive four-digit status indicator changes to -PS- and scrolls IP address, which indicates that upgrading is in progress.

   After the upgrade information is sent to the drive, the drive resets and performs diagnostic check in. It will display 350, -08-, and scroll -00- and the IP address.



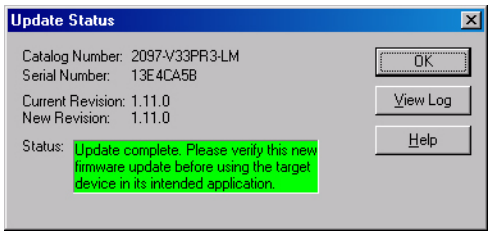
9. Wait for the Progress dialog box to time out.

   It is normal for this process to take several minutes.

IMPORTANT	Do not cycle power to the drive during this process or the firmware upgrade will not complete successfully.

10. The Update Status dialog box opens and indicates success or failure as described below.

Upgrading Status	If
Success	1. Update complete appears in a GREEN Status dialog box. 2. Go to step 11.
Failure	1. Update failure appears in a RED Status dialog box. 2. Refer to ControlFLASH Firmware Upgrade Kit Quick Start, publication 1756-QS105, for troubleshooting information.



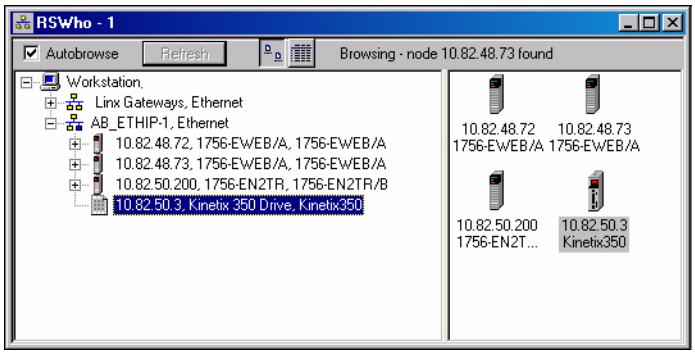
11. Click OK.

Verify the Firmware Upgrade

Follow these steps to verify your firmware upgrade was successful.

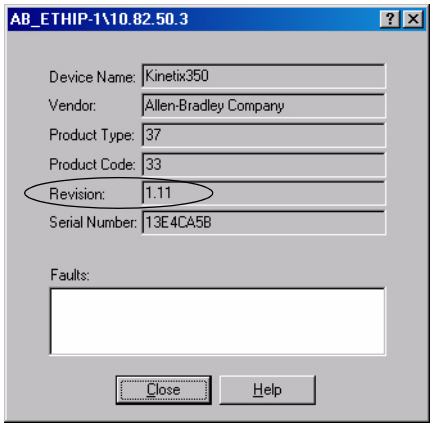
TIP Verifying the firmware upgrade is optional.

1. Open your RSLinx software.
2. From the Communications pull-down menu, choose RSWho.



3. Expand your Ethernet node, Logix backplane, and EtherNet/IP network module.
4. Right-click the drive module and choose Device Properties.

   The Device Properties dialog box opens.



5. Verify the new firmware revision level.
6. Click Close.

Notes:

Numerics

A

B

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Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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Rockwell Automation Publication 2097-UM002A-EN-P - August 2011

Allen-Bradley

Kinetix 350 Single-axis EtherNet/IP Servo Drives

User Manual